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U. S. DEPARTMENT OF AGRICULTURE,  
BUREAU OF ANIMAL INDUSTRY—BULLETIN NO. 53.

D. E. SALMON, D. V. M., Chief of Bureau.

REPORTS

ON

BOVINE TUBERCULOSIS AND PUBLIC HEALTH.

BY

D. E. SALMON, D. V. M.,

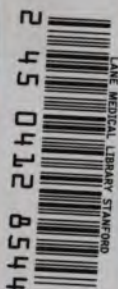
*Chairman of the Committee on Animal Diseases and Animal Food  
of the American Public Health Association.*



WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1904.



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(Continued on third page of cover.)

<sup>a</sup>Transferred August 16, 1902, to the Marine Hospital Service, as Chief of Division of Zoology, but remained in the Zoological Division, Bureau of Animal Industry.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ANIMAL INDUSTRY—BULLETIN NO. 53.

D. E. SALMON, D. V. M., Chief of Bureau.

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## REPORTS

ON

# BOVINE TUBERCULOSIS AND PUBLIC HEALTH.

BY

D. E. SALMON, D. V. M.,

*Chairman of the Committee on Animal Diseases and Animal Food  
of the American Public Health Association.*



WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1904.

## LETTER OF TRANSMITTAL.

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U. S. DEPARTMENT OF AGRICULTURE,  
BUREAU OF ANIMAL INDUSTRY,  
*Washington, D. C., November 21, 1903.*

SIR: I have the honor to transmit herewith a manuscript entitled "Reports on Bovine Tuberculosis and Public Health," and recommend that it be published as Bulletin No. 53 of the Bureau series. The subject-matter of this manuscript is the annual reports on the relationship between bovine and human tuberculosis made to the American Public Health Association for the years 1901, 1902, and 1903 by me as chairman of the committee on animal diseases and animal food, a position which I have held during these years.

The first of these reports was published as Bulletin No. 33 of this Bureau, but the supply is about exhausted. It is included herewith because of the demand for all three reports from a class of people who will make the best possible use of the information given.

Respectfully,

D. E. SALMON,  
*Chief of Bureau.*

Hon. JAMES WILSON,  
*Secretary.*

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# BOVINE TUBERCULOSIS AND PUBLIC HEALTH.

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## INTRODUCTION.

Owing to the interest manifested in recent years in the subject of bovine tuberculosis, and particularly in the danger of its being communicated to mankind, it devolved upon the writer, as chairman of the committee on animal diseases and animal food of the American Public Health Association, to prepare and submit reports covering the essential points of this subject and presenting the most striking evidence in his possession. These reports are published herewith. The more important points embraced in the discussion are as follows:

- (1) Extent of bovine tuberculosis in Europe and the United States.
- (2) Effect of products of diseased animals upon the health of consumers, without reference to the direct transmission of a contagious disease.
- (3) The accidental infection of man by inoculation with bovine bacilli.
- (4) The infection of man by consuming the milk of tuberculous cows.
- (5) The results of scientific experiments with regard to the transmission of tuberculosis from man to bovine animals and vice versa.

The results of recent experiments, both in Europe and in the United States, demonstrate that quite frequently tuberculosis bacilli are found in the human subject which are virulent for bovine animals. It must be admitted, therefore, that either the human bacillus under certain conditions takes on an unusual virulence and is then practically identical with the bovine bacillus, or that these especially active bacilli have originated in cattle and caused disease in man. In either case the arguments which have been particularly urged during the last few years against the danger from bovine tuberculosis are shown to be weak and out of harmony with clearly established facts.

The development of our knowledge concerning this question has been rapid, and the facts brought together in these reports will give those interested in the subject a fairly clear idea of its present status.

D. E. SALMON.



## **BOVINE TUBERCULOSIS AFFECTING THE PUBLIC HEALTH. (First report.)<sup>a</sup>**

By D. E. SALMON, D. V. M.,

*Chief of the Bureau of Animal Industry and Chairman of the Committee on Animal Diseases and Animal Food of the American Public Health Association.*

Your committee on animal diseases and animal food has been impressed with the importance of the discussions which occurred at the recent British Congress on Tuberculosis concerning bovine tuberculosis and its effects upon the public health. Some of the opinions expressed at that congress have aroused the most extended interest among physicians and among laymen, and it seems appropriate that your committee should at this time review the subject at some length, in order to make clear what is already known, preparatory to taking steps definitely to settle contested questions by experimentation.

### **EXTENT OF BOVINE TUBERCULOSIS.**

The extent and rapid increase of bovine tuberculosis in various countries has during recent years caused alarm, both because of its effects in reducing the general food supply and its supposed danger to human health.

The slaughterhouse statistics of Prussia show 14.6 per cent of the cattle and 2.14 per cent of the hogs to be tuberculous. In Saxony the percentage is 29.13 for cattle and 3.10 for hogs. In the city of Leipzig the figures are 36.4 for cattle and 2.17 for hogs. (Siedamgrotzky.) Of 20,850 animals in Belgium tested with tuberculin in 1896, 48.88 per cent reacted. (Stubbe.) Of 25,439 tested in Denmark from 1893 to 1895, 49.3 per cent reacted; and of 67,263 tested from 1896 to 1898, 32.8 per cent reacted. (Bang.) An examination of 20,930 cattle in Great Britain, either slaughtered and examined post-mortem or tested with tuberculin, showed 5,441, or 26 per cent, affected with tuberculosis. McFadyean estimates that 30 per cent of the cows in Great Britain are tuberculous.

Figures available in the United States do not cover a sufficient area of our territory to allow us to make a reliable estimate of the extent of tuberculosis with milch cows. There is little doubt, however, but that the disease has been increasing both with dairy cattle and hogs.

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<sup>a</sup> Report of committee on animal diseases and animal food to the American Public Health Association, at Buffalo, N. Y., September 16-20, 1901. Published also as Bulletin No. 33 of the Bureau of Animal Industry.

From a recent review by Russell and Hastings, of the Wisconsin Agricultural Experiment Station, of tests of cattle for tuberculosis which have been made in the United States, the following summary is presented:<sup>1 a</sup>

*Statistics of tests for tuberculosis in the United States.*

| State.                                                                                                                                | Number tested. | Number tubercular. | Per cent tubercular. |
|---------------------------------------------------------------------------------------------------------------------------------------|----------------|--------------------|----------------------|
| Vermont .....                                                                                                                         | 60,000         | 2,390              | 3.9                  |
| Massachusetts .....                                                                                                                   | 24,685         | 12,443             | 50.0                 |
| Massachusetts, entire herds .....                                                                                                     | 4,093          | 1,080              | 26.4                 |
| Connecticut .....                                                                                                                     | 6,300          | .....              | 14.2                 |
| New York, 1894 .....                                                                                                                  | 947            | 66                 | 6.9                  |
| New York, 1897-98 .....                                                                                                               | 1,200          | 163                | 18.4                 |
| Pennsylvania .....                                                                                                                    | 34,000         | 4,800              | 14.1                 |
| New Jersey .....                                                                                                                      | 2,500          | .....              | 21.4                 |
| Illinois, 1897-98 .....                                                                                                               | 929            | .....              | 12.0                 |
| Illinois, 1899 .....                                                                                                                  | 3,655          | 560                | 15.32                |
| Michigan .....                                                                                                                        | .....          | .....              | 13.0                 |
| Minnesota .....                                                                                                                       | 3,430          | .....              | 11.1                 |
| Iowa .....                                                                                                                            | 873            | 122                | 13.8                 |
| Wisconsin:                                                                                                                            |                |                    |                      |
| Experiment station tests—                                                                                                             |                |                    |                      |
| Suspected herds .....                                                                                                                 | 323            | 115                | 35.6                 |
| Nonsuspected herds .....                                                                                                              | 935            | 84                 | 9.0                  |
| State veterinarian's tests—                                                                                                           |                |                    |                      |
| Suspected herds .....                                                                                                                 | 588            | 191                | 32.5                 |
| Tests of local veterinarians under State veterinarian (cattle intended for shipment to States requiring tuberculin certificate) ..... | 3,421          | 76                 | 2.2                  |

The State veterinarian of Pennsylvania, Dr. Pearson, thinks that not over 2 per cent of the cattle of that State are tuberculous, and probably if a general test of all the cattle of the other States mentioned were made we should find a very much smaller proportion tuberculous than is indicated by this tabular statement. The explanation of the high percentages that have been given is found in the fact that it has been for the most part suspected herds which have been tested. Admitting that the greater part of these percentages are too high, they are still sufficient to demonstrate the wide distribution of tuberculosis and its comparative frequency.

Our beef cattle, as they come to the large packing houses, are yet comparatively free from tuberculosis. Of 4,841,166 cattle slaughtered in the year 1900 under Federal inspection, but 5,279, or 0.11 per cent, were sufficiently affected to cause the condemnation of any part of the carcass. Of 23,336,884 hogs similarly inspected, 5,440 were sufficiently affected to cause condemnation of some part of the carcass. This is equal to 0.023 per cent, or slightly more than one-fifth the proportion found in beef cattle.

<sup>a</sup>References are to bibliography at end of bulletin.

The slaughterhouse statistics of all countries show that the percentage of affected hogs increases as the disease becomes more common in cattle, so that we must consider not only the effect of the disease upon beef and milk producing animals, but also upon hogs. The disease is more acute with hogs than with cattle, and there is a much greater tendency to generalization, and consequently the parts used for human food are more likely to be affected; and if there is a possibility of communicating the disease through the meat the danger is increased by this peculiarity of these animals.

#### EFFECT OF PRODUCTS OF DISEASED ANIMALS ON PUBLIC HEALTH.

Admitting, as we must, the increase of this disease among our food-producing animals, particularly cattle and hogs, it appears that this fact should cause concern from a public health standpoint irrespective of the question of the direct communicability of tuberculosis from animals to man. The people of the United States have always demanded meat from animals which were free from disease. Animal food has been so abundant and so cheap that even the poorer classes of our population have been able to use the best. There is no reason apparent at this time why there should be a departure from this rule and they be expected to consume the products of animals affected with tuberculosis. Animals so affected often have mixed infection, with high temperature, the formation of pus in different parts of the body, and particularly in the mammary glands, and there is undoubtedly in many cases a considerable development of toxins. The flesh of such animals must be affected in the same way as is that of animals affected with other fevers and septic conditions. The extensive development of tubercular lesions in the udder affects the secretion of milk, changes its composition, causes the secretion of great quantities of pus which are mixed with the milk, and leads to the development of a great variety of saprophytic germs which multiply in the milk and develop various decomposition products.

The consumption of food of this character has always been considered harmful, and especially so to children. It may seriously affect the digestion and cause diarrhea and other forms of illness by the toxins which are taken. It is extremely desirable that the source of our food supply should be guarded from contamination by disease and kept in as nearly a normal and healthy condition as possible. Every departure from this ideal state is a menace to the consumer and an injury to the public at large.

#### THE COMMUNICABILITY OF BOVINE TUBERCULOSIS TO MAN.

The important question as to whether bovine tuberculosis can be directly communicated to man has attracted considerable attention in this country for several years, and was discussed by the committee on

animal diseases and animal food at the last meeting. The conclusion had already been reached by some writers in this country that mankind was not susceptible to the form of tuberculosis which affects cattle. Now that this conclusion has been accepted and promulgated by Koch<sup>a</sup> in his address at the British Congress on Tuberculosis, and has been received so seriously by people generally as well as by the medical profession, it is deemed desirable to recapitulate what was said at that time and to add such further evidence and arguments as are available.

In this discussion we should never lose sight of the fact that, even if Koch's position is correct as to the insusceptibility of mankind to bovine tuberculosis—a conclusion which your committee believes is unwarranted by the evidence—and if it is admitted that it is unnecessary to adopt measures against the bovine disease in the fight against human tuberculosis, it does not follow, by any means, that the products of these diseased animals are harmless and should be allowed to go into consumption. Nevertheless, Koch's conclusion is being used already as an argument and excuse for the sale of tuberculous meat and milk. This discussion as to the communicability of bovine tuberculosis should not be allowed to obscure the general question of the importance of condemning meat and milk of diseased animals, whether the disease is or is not a specific one which may be communicated to the consumer of these products. There is no argument to justify the sale of milk secreted by tuberculous udders, reeking with pus and the microorganisms which it contains, changed in its chemical composition, and unsavory to every civilized person. The question of the desirability of measures against bovine tuberculosis as a part of the campaign against human tuberculosis is a thing by itself and entirely distinct from the desirability of such measures from an economic and general public-health standpoint.

Whenever this question is discussed in medical meetings or medical journals the general excuse for a toleration of the present condition of affairs is that the danger from bovine tuberculosis has been greatly exaggerated. Quite likely it has been exaggerated by some individuals, but it has just as certainly been underestimated by others. What has been the effect of the discussions heretofore held? Have the public been too much alarmed? Have sanitarians gone to too great extremes? Have we anywhere a too rigid meat inspection or a too careful supervision of the milk supply? If so, your committee is not aware of the fact. And, until this occurs, the repetition of the statement that the danger from bovine tuberculosis has been exaggerated appears to be entirely superfluous and useless.

Koch in his recent paper makes two radical assumptions: First, human tuberculosis differs from bovine tuberculosis, and can not be communicated to cattle; second, mankind is nearly, if not absolutely, insusceptible to bovine tuberculosis. It is incumbent upon us to

examine the evidence upon which these propositions rest, for if they can be demonstrated the fact would be welcomed by every sanitarian, not because it would no longer be necessary, for economic and public health reasons, to control bovine tuberculosis, but because it would prove that some dangers which we have hitherto feared do not exist, and it would simplify the measures needed in the warfare against human tuberculosis. We should not allow ourselves, therefore, to be biased by preconceived opinions, but should honestly and conscientiously weigh all evidence that is presented.

Neither of these propositions is original with Koch, but this is probably the first time that a scientific man of such standing and authority has ventured to adopt them. Sidney Martin, in his experiments for the British Royal Tuberculosis Commission of 1895, showed that sputum from man was far less virulent for animals than was bovine tubercular material. Theobald Smith, Frothingham, and Dinwiddie have repeated these experiments with cattle and other animals and incontestably demonstrated this conclusion. It does not appear to be entirely correct, however, to say that human tuberculosis is not communicable to cattle. It would be more accurate to say that in the experiments referred to human tuberculosis was only communicated with difficulty to cattle, and when it was communicated it remained localized and did not cause a fatal disease.

Of 6 calves to which sputum was fed by Martin, 2 showed no lesions, 1 had 53, 1 had 63, and 2 had 13 tubercular nodules, respectively, in the intestines. In 1 of these animals the mesenteric glands were also affected. Smith also produced small lesions in some of the animals with which he experimented. The failure to cause fatal disease in cattle with sputum bacilli appears to be due to lack of virulence, or, we might say, to low pathogenic power, rather than to any essential difference in bacilli from human and bovine sources. This is shown by the fact that human bacilli were less active, not only when inoculated upon cattle, but also when inoculated upon other species of animals.

The experiments of Chauveau,<sup>3</sup> which were made prior to those mentioned above, are more conclusive and can not be ignored in discussing this question. In one series of experiments he infected 2 heifers and a bull, all under 1 year old, with emulsions made from tuberculous human lungs. These infections were by ingestion, but two doses being given to each animal. One of the heifers, killed 57 days after infection, had more than 200 tubercles of different sizes in the small intestines. There were also tubercles in the cecum, colon, abomasum, liver, and peritoneum. The autopsy on the second heifer occurred 59 days after infection. In this case the abdominal lesions were insignificant, consisting of two or three follicular hypertrophies in the jejunum and a few small tubercular mesenteric glands. The right submaxillary gland and the two retropharyngeal glands were enlarged and affected with

typical tubercular infiltration. The lungs showed not less than 12 tuberculous centers, most of them the size of a walnut, and near these masses were points where tubercular infiltration was beginning. All the bronchial and mediastinal glands were enlarged, tuberculous, and infiltrated with gray and yellow matter. The bull was destroyed on the thirty-fourth day. There was a plain tuberculous eruption in the small intestine, some portions of the mucous membrane, particularly on the Peyer's patches, being covered with confluent tubercles. In the left lung there was a single tuberculous nodule of considerable size, and some lobules presented a gelatinous appearance and consistency. There were aggregations of small tubercles in the larynx and upper part of the trachea, some of which were already ulcerated. There were also tubercular granulations in the bronchi. At the time these animals were infected, 3 similar animals were infected in like manner with bovine material, and 3 others were held as checks. The latter were found free from tuberculosis. At the autopsy it was impossible to distinguish any difference between the animals infected with human and those with bovine material. All were affected, and with all the tuberculous lesions had the same characters.

Chauveau, also, made comparative experiments by intravenous injection and subcutaneous inoculation; from all of these he concluded that the human tuberculous virus acts on the bovine species exactly like the tubercular virus which comes from the bovine species itself.

That the diseases are not absolutely distinct is indicated by the fact that tuberculin made from human bacilli causes a reaction in cattle affected with bovine tuberculosis. The Bureau of Animal Industry has distributed hundreds of thousands of doses of tuberculin made from human bacilli, and this tuberculin has been used by State authorities in various parts of the United States for diagnosing the disease in cattle, and has been found extremely reliable and satisfactory for this purpose. This fact would clearly indicate that if there is a difference between bacilli from human and bovine sources—and your committee is inclined provisionally to admit such a difference—it consists in minor biological variations and not in the germs being specifically distinct.

In discussing the susceptibility of man to bovine tuberculosis, it appears to your committee that Koch has simply begged the question. Even if we admit that human tuberculosis is not readily communicable to cattle, the conclusion that bovine and human tuberculosis are entirely different and not intercommunicable between these species does not necessarily follow. Another possible conclusion, and one more in harmony with what is known of comparative pathology, is that the bovine bacillus, being proved more virulent for all animals upon which it has been tried, is also more virulent for man.

As pointed out in this committee's report of last year, there is no contagion which affects so many and such widely separated species of

animals as does the bovine bacillus and which is not at the same time pathogenic for man. Bovine tuberculosis is communicable to horses, cattle, sheep, hogs, dogs, cats, guinea pigs, and rabbits. This is a very extensive range of pathogenic power. What other pathogenic germ is there which is virulent for so many and such widely separated species and which is not virulent also for man?

As examples of diseases which affect many species of animals, we have anthrax, rabies, glanders, malignant edema, and tetanus, to all of which mankind is susceptible. As examples of diseases which affect a fewer number of species, we have epizootic aphtha, which principally affects cattle and hogs, and which is communicable to man; we have vaccinia, or cowpox, which affects horses and cattle and which is communicable to man; we have rinderpest, which affects only ruminants and which is not communicable to man; we have pleuropneumonia and Texas fever, which affect cattle and are not communicable to man; and we have sheep pox, which affects sheep only, and hog cholera affecting hogs only, which are not communicable to man. The rule appears to be that the larger the number of animal species susceptible the more likely is a contagion to affect man. Surely a germ which is pathogenic for so many species of animals as is the bovine tubercle bacillus should be considered as dangerous to man until positive evidence has proved its innocence.

We are not without parallel cases in comparative pathology which should be considered in deciding such an important question. One of these is found in rabies. When the contagion of this disease is inoculated into monkeys and passed from one animal of this species to another for a few times, the virus, as is well known, becomes so lacking in pathogenic power that it no longer produces rabies in dogs when inoculated in the usual manner. It must be apparent to all how wrong it would be to conclude that because rabies of monkeys is not communicable to the dog, conversely the rabies of the dog is not communicable to monkeys; yet this appears to be exactly the kind of assumption which Koch has made in regard to the bovine tubercle bacillus.

Another parallel case is found in variola. The variola of man, commonly called smallpox, is conveyed to cattle with much difficulty. Like human tuberculosis, it produces, when inoculated in these animals, only insignificant results when compared with the disease in man, with no tendency to generalization or to the production of fatal results, but, on the other hand, the tendency is to retrogression and healing. Nevertheless, the bovine variola, known as vaccinia, or cowpox, is easily inoculated upon man, develops to the same extent as in cattle, produces characteristic lesions, runs its regular course, and may be transferred from man to man an indefinite number of times, as has been shown in the practice of vaccination. If cowpox had



never been experimentally tested upon man, and we had only the results of experiments in inoculating smallpox upon cattle, we should have the same reason for concluding that vaccinia is not communicable to man that has been cited in the case of tuberculosis.

Koch alludes to two kinds of evidence available for deciding this question: First, the demonstration of cases of primary intestinal infection in man; secondly, the inoculation of cattle with bacilli found in cases of human tuberculosis. It appears to your committee that his treatment of this question is very narrow and unsatisfactory. In deciding as to the susceptibility of man the evidence now available may be classified under four heads: (1) Accidental inoculations with bovine bacilli; (2) clinical evidence of individuals infected by use of milk; (3) statistics of abdominal tuberculosis; (4) results of post-mortem examinations. We shall discuss the subject under these four heads.

#### ACCIDENTAL INOCULATIONS OF MAN WITH BOVINE BACILLI.

The first and most important line of evidence is that obtained from accidental inoculations of man with bovine bacilli. Ravenel<sup>4</sup> has put on record three cases of veterinarians in the State of Pennsylvania who were accidentally inoculated with bovine tuberculosis in making post-mortem examinations. Case 1 was accidentally wounded in the knuckle of his forefinger. The wound healed badly and a nodule soon formed which showed a decided tendency to ulcerate. After some weeks he had the nodule removed, and a section of the excised portion was found to contain a large giant cell, but tubercle bacilli were not satisfactorily demonstrated in the preparation. The nodule recurred after excision and was finally cured by treatment in the hot-air apparatus. Case 2 was Ravenel's assistant, who scratched his knuckle on the broken end of a rib in performing a postmortem on a goat which had succumbed to an experimental inoculation with a culture of bovine tubercle bacillus. The wound healed promptly, but about 3 weeks afterwards became reddened, swollen, and sensitive. It grew worse and was finally excised with a margin of healthy skin. Two guinea pigs were inoculated subcutaneously with a portion of this nodule and both developed a generalized tuberculosis. Case 3, a well-known veterinarian of Philadelphia, wounded the knuckle of his forefinger in making an autopsy on a tuberculous cow. Between 3 and 4 weeks afterwards the scar was noticed to be enlarged, reddened, and somewhat sensitive. As it showed no tendency to improve, but rather grew worse, it was excised some 6 weeks after the inoculation and the wound cauterized with bromine, since which there has been no return. The nodule was examined by Dr. John Guiteras, who demonstrated its tuberculous nature by finding tubercle bacilli in sections.



L. Pfeiffer<sup>5</sup> cites the case of Veterinarian Moses, 34 years old, of healthy family and personally in good health, who pricked his left thumb in making an autopsy on a tuberculous cow. The point of the knife probably penetrated into the articulation of the first and second phalanges. The puncture healed without suppuration, but at the end of 6 months there formed at the cicatrix a cutaneous tubercle, and the joint was removed. Soon afterwards the patient began to cough, and died of phthisis 18 months after the accident. On opening the articulation of the thumb it was found filled with caseous masses extraordinarily rich in tubercle bacilli.

A somewhat similar case occurred in the practice of M. B. Hartzell, of Philadelphia, and was partially reported at the meeting of the American Medical Association, held at Philadelphia June 1 to 4, 1897. Further details have been received through Ravenel. The patient, a man in excellent health and weighing 175 pounds, was employed by a railroad company to clean cars used for the transportation of cattle. He was wounded upon the back of the hand by a piece of broken wood-work of a car, and typical verrucous tuberculosis developed locally. This was apparently successfully treated by Hartzell. Within a year the patient's general health changed greatly; he was emaciated, had a persistent cough with abundant expectoration, and there was a decided dullness at the left apex, with numerous râles. Death soon resulted from general tuberculosis.

A very interesting case of "primary subcutaneous tuberculosis," caused by the topical application of cream, was reported by Grothan.<sup>6</sup> A little girl 6 years old had suffered from an eruption on the left leg, supposed to be due to ivy poisoning. This was treated at home by the topical application of fresh cream. When seen by Grothan there was a painless ulcer of irregular shape the size of a 25-cent piece on the posterior aspect of the leg, having the characteristic appearance of a tubercular ulcer, with reddish tinged borders slightly overhanging the floor, which was covered with granulations and watery pus. There were also about a dozen light-mahogany colored spots confined to the calf of the leg and the lower third of the thigh, varying from the size of a hazelnut to the half of a large walnut, and containing masses of caseous material. The cow was examined and the udder seemed normal, yet inguinal and intraperitoneal inoculation of two rabbits with a mixture of milk and cream gave positive results in both inguinal inoculations and one peritoneal. The caseous material from the nodules of the girl's leg injected into the peritoneum of a rabbit produced tuberculous peritonitis and death in about 3 weeks. The family was using milk from one cow only at the time the application was made.

A somewhat similar case was recorded by Coppez.<sup>7</sup>

A girl 17 years old had a wound on the palmar aspect of the third finger between the second and third phalanx, which became infected with tubercle bacilli during

milking. The original lesions gave rise, within 6 months, to over 35 subcutaneous abscesses situated in different parts of the body. There were 2 on the right hand, 4 on the elbow, 2 on the shoulder blade, several on the right cheek, 2 on the left palm, 1 on the back of the neck, a dozen on the buttocks and thighs, 4 on the left leg, 3 on the sole of one foot, and 1 on the big toe. Most of these were curetted and iodoform applied 6 months after the beginning of the disease. Subsequently more appeared—in all from 60 to 66. The author describes the appearance of these foci as follows:

At a certain point, always in the neighborhood of a preexisting focus, a thickening of the subcutaneous tissue appeared, associated with increased heat of the skin and pain on pressure. The heat soon disappeared and a fluctuating livid tumor opened itself and discharged pus, and later a yellowish serum. These various abscesses healed slowly, and within a year all disappeared. At no time could any visceral lesions be recognized, but one eye became involved. The nature of the affection was demonstrated by inserting some pus from an abscess into the eye of a rabbit. There was but slight reaction at first. Subsequently the whole eye became diseased, the lymph nodes of the neck being greatly enlarged. After several months death ensued.

A third case of tuberculosis communicated by inoculation with infected milk was reported by Priester.<sup>8</sup>

A young man employed on the docks tried to remove a number of tattoos from his hands and forearms by introducing milk into the tattooed parts by means of needle punctures. This operation was repeated several times. Later there appeared on the back of both hands, at points which had been treated on the same day, bright red spots the size of millet seeds, containing a yellow center. Pus was evacuated from several nodules. These were found to be lupus nodules (tuberculosis of the skin) in which giant cells were demonstrated. The diseased parts were cut out and the wounds healed without a recurrence of the trouble.

Tscherning,<sup>9</sup> of Copenhagen, treated a veterinarian whose finger had been wounded in making a postmortem examination of a tuberculous cow. Three weeks after the accident, the slight wound having already healed, the surrounding tissues became swollen, and a little later a suppurating ulcer formed. Notwithstanding an appropriate treatment, the local disease became worse and it was necessary to excise all of the swollen tissue. Microscopic examination demonstrated tubercles with bacilli. The patient recovered without further development of the disease.

M. T. Naughton, Chicago, Ill., has communicated to this committee the following case, which was observed in his practice:

G. E. W., Pole; age, 34; weight, 170 pounds; healthy looking man; butcher by occupation. Family history negative. Father of three healthy children. Has no recollection of having been previously sick. On May 3, 1899, while cleaning cattle viscera, he fell and a stationary meat hook upon which hearts and lungs are hung penetrated through the right hand between the second and third metacarpal bones. A tendo vaginitis resulted, with some lymphangitis of the arm. He received the usual treatment for an infected wound and apparently made a good recovery, with, however, some limited motion of the fingers and a sensitive scar at the site of puncture. Four months afterwards an abscess formed in the axilla, which was cleaned out and tubercle bacilli were demonstrated in the broken-down gland tissue. At this time there was no soreness in the arm lymphatics or elbow gland, but he complained that there had been. In 3 months afterwards, or 7 months from the original accident, he died from pulmonary tuberculosis.

These are very clear cases and could be multiplied if necessary to add strength to the evidence. These cases demonstrate the susceptibility of man to infection by bovine bacilli inoculated into the skin or subcutaneously. Not only were local lesions produced, but in some cases the disease was generalized and ended in death. The value of such cases of inoculation in demonstrating the susceptibility of man has been questioned on the ground that the lesions resulting from inoculation of the skin are usually slight and remain localized. While it is true that they remain localized in most cases, they have sometimes been attended by fatal results, and in all cases appear to be at least as serious as similar inoculations with the human bacillus. The human bacillus is known to be pathogenic for man and it causes one of the most fatal of human diseases. Now, if the bovine bacillus, when inoculated in the skin, produces at least as serious results as the human bacillus we have a right to conclude that mankind is equally susceptible to the bovine as to the human form of contagion.

It is reported that one of the foreign delegates said in the British congress that the inoculation of man from animals is a different thing from infection by way of the alimentary tract. While this may be admitted, it is nevertheless true that the human bacillus, which may infect man by way of the alimentary tract, is only inoculated in the skin with difficulty, as is shown by the insignificant lesions which usually follow inoculations in making autopsies and dissections. In other words, the alimentary tract appears to be a more favorable route of entrance for the human bacillus than is the skin, and consequently if the bovine bacillus is able to enter the body by means of skin inoculations, there is every reason to believe that it may also enter by way of the alimentary tract.

These very clear cases appear to demonstrate the communicability of bovine tuberculosis to man and to indicate that the bacilli from a bovine source are at least as virulent for man as are bacilli from a human subject. It will not do to put these cases aside, saying that such inoculations are another matter from intestinal infection, because the great point to be decided is the susceptibility of man to the bovine bacillus; and it will be observed that Koch proposes in testing the virulence of bacilli from the human subject to do this by subcutaneous inoculations in cattle. If such inoculations are a proper test of susceptibility in the one case why are they not equally so in the other?

#### TUBERCULOSIS IN MAN BELIEVED TO HAVE BEEN CAUSED BY INGESTION OF MILK FROM TUBERCULOUS COWS.

The second class of evidence to which your committee would refer is the clinical observation of individuals infected by the ingestion of milk. One of these frequently cited is a case reported by Ollivier to

the Paris Academy of Medicine.<sup>10</sup> Twelve girls contracted tuberculosis in a young ladies' boarding school. Of these 5 died. From the fact that the sick and deceased girls were descended from healthy ancestors and, above all doubt, showed the phenomena of intestinal tuberculosis, there was suspicion of infection with the food. Full confirmation of this suspicion was found in the slaughter of a cow which for a year had served as a source of milk supply for the school. The cow had extensive tuberculosis of the intestines and udder. This case has particular value because of the number of persons affected, the fact that they had intestinal tuberculosis, and the demonstration of udder tuberculosis in the cow.

Another case is cited by T. Percy C. Kirkpatrick.<sup>11</sup> This was the case of a daughter of a Dr. Gosse, of Geneva, reported by himself. The girl up to the age of 17 had been quite healthy and had no history of hereditary taint or predisposition to tuberculosis. Early in 1893 she became ill, with more or less vague and undefined symptoms, and died in some 10 months. Gosse performed a postmortem examination, and discovered extensive tuberculosis of the mesenteric glands and abdominal viscera. When trying to find the source of infection in this case, Gosse's attention was drawn to a small farm which he possessed in the country and which he had been accustomed to visit on Sundays with his daughter, and one of her chief delights was to drink milk from the cows there. On examination 4 of the 5 cows were tubercular and 2 had disease of the udder.

An interesting case was under the care of Thomas M. Rotch in the Children's Hospital, in Boston, in 1893 or 1894. The particulars were sent to Dr. de Schweinitz, of the Bureau of Animal Industry, by Rotch. A boy 7 years old had been drinking a great deal of milk from one cow for about 4 months before entering the hospital. The cow was found to be tuberculous, the disease being demonstrated by autopsy. The boy was a case of primary tubercular peritonitis, with effusion. Laparotomy was performed by Dr. Bradford, and a large amount of serous fluid evacuated. The peritoneum was found to be thickly studded with minute tubercles, and the presence of tubercle bacilli was demonstrated. Four years after the operation the boy was found to be perfectly well and seemed free from tuberculosis.

Lydtin<sup>12</sup> gives the following case: Dr. Stang, of Amorbach, was called to a finely developed 5-year-old boy, the son of healthy parents, with no hereditary taint in their ancestors. The boy died a few weeks later with miliary tuberculosis of the lungs and enormously enlarged tubercular mesenteric glands. At the necropsy it was learned that the boy had habitually drunk the milk of a cow which had been killed shortly before he died and which had shown pulmonary tuberculosis.

Mr. Howe, of North Hadley, Mass., lost a son 20 months old from abdominal tuberculosis 3 months after he paid a week's visit to his

uncle and had been fed with milk of the uncle's cow. The cow was killed soon afterwards and proved to have generalized tuberculosis. The child's sickness and wasting began a few weeks after he returned home. He had previously been strong and healthy, as were and are his parents.<sup>13</sup>

A 4-year-old son of Colonel Beecher, of Yonkers, and grandson of Henry Ward Beecher, died March 4, 1894, of tubercular meningitis, and the two Alderney cows which supplied him milk were proved tuberculous by the tuberculin test and postmortem examination. There was no hereditary taint.<sup>13</sup>

A Scotch family, strong and healthy, had a herd of cows which contracted tuberculosis. Two young daughters brought up on the milk died of tuberculosis, while 2 older brothers, using little or no milk, remained well and hardy.<sup>14</sup>

Dr. Demme,<sup>15</sup> chief physician of the Children's Hospital, Berne, records the cases of 4 children, born of healthy parents and without tuberculous ancestors either on the paternal or maternal side, who died of intestinal and mesenteric tuberculosis, having consumed for some time milk furnished by tuberculous cows. Among 2,000 tuberculous children treated by Dr. Demme in 20 years, these were the only ones in which he could absolutely exclude the possibility of hereditary taint and all other causes of the disease except milk infection.

Von Ruck<sup>16</sup> records the following case, which he considers almost conclusive:

M., age 33, weight 180 pounds, was treated by his family physician about 6 weeks for what was supposed to be typhoid fever. Growing worse when convalescence was looked for, Von Ruck was called in consultation. Diagnosis of acute miliary tuberculosis was soon established. The autopsy showed the usual dissemination of the tubercular process, but no old focus was found in chest or abdomen, which only were permitted to be examined. Family and personal history good; and the source and mode of infection remained for the time obscure.

A few days after M.'s death, Von Ruck was called to see his nearly 1-year-old child on account of fever and diarrhea, which yielded to treatment, but the child did not recover its former good health. Gradually symptoms of meningitis developed and the child died. No postmortem was permitted, but there was no doubt of the tubercular character of the meningitis. Infection from father was not probable, the child having been removed from the house at an early period of his illness.

The milk which the child had received came from a Jersey cow, and no other had been used up to the time the diet was changed on account of the diarrheal attack. The father had drunk largely of this cow's milk, taking a pint and sometimes a quart twice a day, warm, at the time of milking, and this cow's milk was given him exclusively during his entire illness. On examination one of the cow's teats was found to be shrunken; it was said to yield little milk, and several months before the milk was occasionally bloody. There was a hard, irregular lump on the same side of the udder. When the cow was killed, several months later, there was found extensive tuberculosis in the lungs and peritoneal cavity, and the lump in the udder contained a caseous center, which on examination showed numerous well-stained tubercle bacilli.

These are examples of clinical evidence which might be greatly extended, but all are, of course, open to the objection that we do not know absolutely that the disease was caused by the bovine bacillus. However, the occurrence of abdominal tuberculosis soon after the use of milk from tuberculous cows is a coincidence which justifies us in accepting the cases as strong circumstantial evidence, not of themselves demonstrating the communicability of bovine tuberculosis, but, taken with other evidence, making a case which it is difficult to contest.

#### STATISTICS SHOWING FREQUENCY OF ABDOMINAL TUBERCULOSIS.

The third line of evidence to which we invite attention is the statistical data available from various parts of the world.

Thorne, in the Harben lectures for 1898, shows from the statistics of England and Wales that between the periods 1851-1860 and 1891-1895 there has been a reduction of the mortality at all ages from phthisis of 45.4 per cent, while from all forms of tuberculosis the reduction has been distinctly less, namely, 39.1 per cent. Taking that form of disease registered under the name of "tabes mesenterica," the reduction at all ages has been but 8.5 per cent; under 5 years of age the reduction has been but 3 per cent; while under 1 year of age there has been an actual increase of 27.7 per cent. This is the milk-drinking age, and the increase of the mortality is very significant at a time when phthisis has been so remarkably reduced. So instructive are these statistics that we reproduce here Thorne's table showing the mortality from this disease:

*England and Wales—Mortality from tabes mesenterica in several periods, 1851-1895.*

| Period.                                                          | Per million living (all ages). | Per million births (under 1 year). | Per million living (under 5 years). |
|------------------------------------------------------------------|--------------------------------|------------------------------------|-------------------------------------|
| 1851-1860.....                                                   | 260                            | 3, 169                             | 1, 625                              |
| 1861-1870.....                                                   | 295                            | 3, 800                             | 1, 856                              |
| 1871-1880.....                                                   | 318                            | 4, 467                             | 2, 028                              |
| 1881-1885.....                                                   | 289                            | 4, 356                             | 1, 852                              |
| 1886-1890.....                                                   | 265                            | 4, 462                             | 1, 764                              |
| 1891-1895.....                                                   | 238                            | 4, 046                             | 1, 577                              |
| Reduction or increase per cent between 1851-1860 and 1891-1895.. | -8. 5                          | +27. 7                             | -3. 0                               |

The conclusions which naturally follow from these statistics are so different from the opinions of many men that numerous attempts have been made to counteract them. Some have held that the cases returned under "tabes mesenterica" could not be relied upon as abdominal tuberculosis. An examination of the evidence presented leads your committee to the conclusion that this point is not well taken.

Still<sup>17</sup> has recorded the results of 769 autopsies on children under 12 years of age at the Hospital for Sick Children, Great Ormonde

street. Two hundred and sixty-nine cases were found showing tuberculous lesions. In those in which the channel of infection could be made out with some certainty the primary infection was as follows: Lung, 105; intestine, 53; ear, 9; bones or joints, 5; that is, the intestinal infections were to the others as 1 to 2.1. With the class of cases where death was caused by some other disease and where tuberculosis either was arrested in an early stage or had not progressed beyond the initial stage, affording almost indisputable evidence of the methods of infection, the infections were thus: By the lung, 26; by the intestine, 16; by the ear, 1. Here the intestinal infections were to the others as 1 to 1.7. In the English statistics the cases of *tabes mesenterica* in children of 5 years and under are to the other forms of tuberculosis as 1 to 1.6. Still's observations are, therefore, a singular indorsement of the accuracy of the returns under the name of *tabes mesenterica*, and as the ages of the children covered by his autopsies were 12 years and under, he has really found a larger percentage of intestinal infection than is indicated by the statistics.

Also J. Walter Carr<sup>18</sup> refers to statistics of necropsies on tuberculous children at the Victoria Hospital. He found 79 in which the disease most probably started in the chest and 20 in which it seemed to have begun in the abdomen. Here the relation between the two forms of infection is 1 to 4. In 26 children with early or limited tuberculosis, the thorax was alone affected in 12 cases and the abdomen in 7, being in the proportion of 1 to 1.7. Of 53 tuberculous children under 2 years of age the disease most probably began in the chest in 43, and in only 5 certainly in the abdomen, the proportion in this case being as 1 to 8.4. Out of 25 children over 5 years of age the disease began in the chest in 12 and in the abdomen in 6, the relation being as 1 to 2.

Shannon<sup>19</sup> collected data from postmortem examinations at the Royal Hospital for Sick Children, Edinburgh, of 355 cases of tuberculosis, in 331 of which he was able to determine the channel of infection. In 67.7 per cent it was respiratory, in 28.1 per cent it was alimentary. This is as 1 to 2.3.

These postmortem examinations, all from English sources, may be accepted as fairly representative of the results of the postmortem room, and they sustain Thorne's contention that the returns in England of *tabes mesenterica* represent with reasonable accuracy the abdominal tuberculosis of children in that country. It may be added that in Still's most recent paper<sup>20</sup> he states that "it would seem, therefore, that, at any rate among hospital patients in London, nearly one-third of the child mortality is due to tuberculosis; and although such an estimate may, for various reasons, be too high when applied to the whole child mortality of this city, it seems almost certain that the average given by the registrar-general's statistics is far too low. During the 5 years

1891 to 1895 the average number of deaths per annum from all causes among children up to the age of 10 years in this city was 36,349; out of these the average number of children certified each year as having died of tuberculosis was 3,335. The evidence of postmortem statistics makes it practically certain that a very much larger number than this died of tuberculous diseases, and probably we should be well within the mark if we said that at least 6,000 children die every year in London alone from tuberculosis." This being the case, and the proportion between *tabes mesenterica* and other forms of tuberculosis remaining the same, there must have been nearly twice as many cases of intestinal tuberculosis in London as were recorded by the registrar-general; but as *tabes mesenterica* is one of the most obscure forms of the disease, the probability is that more children affected with this form of tuberculosis were otherwise reported than was the case with phthisis, tubercular meningitis, and other forms of tuberculosis that were more easily diagnosed. At any rate, it may be accepted as certain that the evidence so far presented has sustained Thorne's conclusions in regard to *tabes mesenterica*. This being the case, your committee deems it advisable to introduce at this point the statistics of England and Scotland and some of the principal cities of the world, showing deaths from different forms of tuberculosis.

*Deaths from tuberculous diseases in England and Wales for the year 1898.*

[Population 31,397,078.]

| Form of disease.                                 | Under 1 year. | Under 5 years. | Under 10 years. | Under 15 years. | Under 20 years. | Under 25 years. | Under 35 years. | All ages. |
|--------------------------------------------------|---------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------|
| <i>Tabes mesenterica</i> .....                   | 3,265         | 5,050          | 5,369           | 5,555           | 5,725           | 5,850           | 6,050           | 6,357     |
| Tubercular meningitis (acute hydrocephalus)..... | 1,985         | 4,904          | 5,791           | 6,147           | 6,339           | 6,451           | 6,573           | 6,681     |
| Other forms of tuberculosis, scrofula.....       | 1,319         | 2,585          | 3,035           | 3,399           | 3,851           | 4,233           | 4,807           | 5,766     |
| Total other than phthisis.....                   | 6,569         | 12,539         | 14,195          | 15,101          | 15,915          | 16,534          | 17,430          | 18,804    |
| Phthisis.....                                    | 493           | 1,491          | 2,126           | 3,127           | 6,437           | 11,212          | 21,007          | 41,335    |
| Total tuberculosis.....                          | 7,062         | 14,030         | 16,321          | 18,228          | 22,352          | 27,746          | 38,437          | 60,139    |

*Deaths from tuberculous diseases in Scotland for the year 1898.*

[Population 4,249,946.]

| Form of disease.                           | Under 1 year. | Under 15 years. | Under 25 years. | All ages. |
|--------------------------------------------|---------------|-----------------|-----------------|-----------|
| <i>Tabes mesenterica</i> .....             | 239           | 788             | 872             | 947       |
| Tubercular meningitis.....                 | 350           | 1,212           | 1,263           | 1,288     |
| Other forms of tuberculosis, scrofula..... | 121           | 459             | 605             | 815       |
| Total other than phthisis.....             | 710           | 2,459           | 2,740           | 3,050     |
| Phthisis.....                              | 78            | 720             | 2,675           | 7,090     |
| Total tuberculosis.....                    | 788           | 3,179           | 5,415           | 10,140    |



*Deaths from tuberculous diseases in London for the year 1898.*

[Estimated population, 4,504,766.]

| Form of disease.                       | Under<br>1<br>year. | Under<br>5<br>years. | Under<br>10<br>years. | Under<br>15<br>years. | Under<br>20<br>years. | Under<br>25<br>years. | Under<br>35<br>years. | All<br>ages. |
|----------------------------------------|---------------------|----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|--------------|
| Tabes mesenterica .....                | 602                 | 838                  | 884                   | 903                   | 915                   | 930                   | 958                   | 997          |
| Tubercular meningitis .....            | 397                 | 989                  | 1,128                 | 1,177                 | 1,197                 | 1,213                 | 1,232                 | 1,250        |
| Other forms of tuberculosis, scrofula. | 285                 | 555                  | 639                   | 693                   | 750                   | 791                   | 865                   | 983          |
| Total other than phthisis .....        | 1,284               | 2,382                | 2,651                 | 2,773                 | 2,862                 | 2,934                 | 3,055                 | 3,220        |
| Phthisis .....                         | 98                  | 308                  | 385                   | 496                   | 851                   | 1,517                 | 3,272                 | 7,812        |
| Total tuberculosis .....               | 1,382               | 2,690                | 3,036                 | 3,269                 | 3,713                 | 4,451                 | 6,327                 | 11,042       |

*Deaths from tuberculous diseases in Berlin for the year 1898.*

[Population, June 30, 1,768,624.]

| Form of disease.                       | Under<br>1<br>year. | Under<br>5<br>years. | Under<br>10<br>years. | Under<br>15<br>years. | Under<br>20<br>years. | Under<br>25<br>years. | Under<br>35<br>years. | All<br>ages. |
|----------------------------------------|---------------------|----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|--------------|
| Tabes mesenterica .....                | 4                   | 14                   | 23                    | 29                    | 30                    | 35                    | 45                    | 71           |
| Tubercular meningitis .....            | 39                  | 163                  | 196                   | 205                   | 210                   | 216                   | 225                   | 237          |
| Other forms of tuberculosis, scrofula. | 20                  | 34                   | 38                    | 40                    | 40                    | 47                    | 62                    | 88           |
| Total other than phthisis .....        | 63                  | 211                  | 257                   | 274                   | 280                   | 298                   | 332                   | 396          |
| Phthisis .....                         | 78                  | 246                  | 300                   | 360                   | 559                   | 983                   | 1,867                 | 3,553        |
| Total tuberculosis .....               | 141                 | 457                  | 557                   | 634                   | 839                   | 1,281                 | 2,199                 | 3,949        |

*Deaths from tuberculous diseases in Paris for the year 1897.*

[Population, 1896, 2,511,629.]

| Form of disease.                       | Under<br>1<br>year. | Under<br>5<br>years. | Under<br>10<br>years. | Under<br>15<br>years. | Under<br>20<br>years. | Under<br>25<br>years. | Under<br>35<br>years. | All<br>ages. |
|----------------------------------------|---------------------|----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|--------------|
| Tabes mesenterica .....                | 4                   | 21                   | 34                    | 47                    | 55                    | 61                    | 83                    | 154          |
| Tubercular meningitis .....            | 140                 | 633                  | 802                   | 837                   | 857                   | 892                   | 943                   | 999          |
| Other forms of tuberculosis, scrofula. | 50                  | 143                  | 174                   | 196                   | 248                   | 346                   | 567                   | 1,168        |
| Total other than phthisis .....        | 194                 | 797                  | 1,010                 | 1,080                 | 1,160                 | 1,299                 | 1,593                 | 2,321        |
| Phthisis .....                         | 48                  | 244                  | 325                   | 456                   | 1,038                 | 1,955                 | 4,296                 | 9,298        |
| Total tuberculosis .....               | 242                 | 1,041                | 1,335                 | 1,536                 | 2,198                 | 3,254                 | 5,889                 | 11,619       |

*Deaths from tuberculous diseases in New York City for the year 1899.*

[Estimated population, 3,550,053.]

| Form of disease.                       | Under<br>1<br>year. | Under<br>5<br>years. | Under<br>10<br>years. | Under<br>15<br>years. | Under<br>20<br>years. | Under<br>25<br>years. | Under<br>35<br>years. | All<br>ages. |
|----------------------------------------|---------------------|----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|--------------|
| Tabes mesenterica .....                | 34                  | 40                   | 40                    | 40                    | 40                    | 40                    | 42                    | 45           |
| Tubercular meningitis .....            | 281                 | 676                  | 750                   | 766                   | 781                   | 795                   | 819                   | 864          |
| Other forms of tuberculosis, scrofula. | 79                  | 175                  | 211                   | 233                   | 272                   | 328                   | 437                   | 613          |
| Total other than phthisis .....        | 394                 | 891                  | 1,001                 | 1,039                 | 1,093                 | 1,163                 | 1,298                 | 1,522        |
| Phthisis .....                         | 98                  | 220                  | 269                   | 362                   | 778                   | 1,751                 | 4,316                 | 8,015        |
| Total tuberculosis .....               | 492                 | 1,111                | 1,270                 | 1,401                 | 1,871                 | 2,914                 | 5,614                 | 9,537        |

[Population, 560,892.]

| Form of disease.                           | Under 1 year. | Under 15 years. | Under 25 years. | All ages. |
|--------------------------------------------|---------------|-----------------|-----------------|-----------|
| Tabes mesenterica .....                    | 2             | 10              | 12              | 18        |
| Tubercular meningitis.....                 | 43            | 117             | 123             | 131       |
| Other forms of tuberculosis, scrofula..... | 20            | 51              | 79              | 181       |
| Total other than phthisis .....            | 65            | 178             | 214             | 330       |
| Phthisis.....                              | 11            | 52              | 318             | 1,247     |
| Total tuberculosis.....                    | 76            | 230             | 532             | 1,577     |

[Population, 1897, 1,619,226; 1898, 1,650,000.]

| Form of disease.                                          | Under 1 year. | Under 5 years. | Under 10 years. | Under 20 years. | Under 30 years. | All ages. |
|-----------------------------------------------------------|---------------|----------------|-----------------|-----------------|-----------------|-----------|
| Tuberculosis mesenteric (1897) and peritoneal (1898)..... | 3             | 12             | 16              | 29              | 33              | 56        |
| Tuberculosis, cerebral.....                               | 75            | 190            | 225             | 249             | 270             | 293       |
| Tuberculosis, other organs.....                           | 40            | 88             | 110             | 158             | 248             | 460       |
| Total other than phthisis.....                            | 118           | 290            | 351             | 436             | 554             | 809       |
| Phthisis.....                                             | 66            | 196            | 250             | 700             | 2,061           | 4,596     |
| Total tuberculosis.....                                   | 184           | 486            | 601             | 1,136           | 2,615           | 5,405     |

To show more clearly the numerical relation of the different forms of tuberculosis, a series of tables of percentages have been compiled, corresponding with those just given, showing the number of deaths.

[Percentage of each form.]

[illegible]

*Deaths from tuberculosis in Scotland for the year 1898.*

[Percentage of each form.]

| Form of disease.                            | Under 1<br>year. | Under 15<br>years. | Under 25<br>years. | All<br>ages. |
|---------------------------------------------|------------------|--------------------|--------------------|--------------|
| Tabes mesenterica .....                     | 30.33            | 24.79              | 16.10              | 9.34         |
| Tubercular meningitis.....                  | 44.42            | 38.13              | 23.33              | 12.70        |
| Other forms of tuberculosis, scrofula ..... | 15.36            | 14.44              | 11.17              | 8.04         |
| Phthisis.....                               | 9.89             | 22.64              | 49.40              | 69.92        |
| Total.....                                  | 100.00           | 100.00             | 100.00             | 100.00       |

*Deaths from tuberculosis in London for the year 1898.*

[Percentage of each form.]

| Form of disease.                            | Under 1<br>year. | Under 15<br>years. | Under 25<br>years. | All<br>ages. |
|---------------------------------------------|------------------|--------------------|--------------------|--------------|
| Tabes mesenterica.....                      | 43.56            | 27.62              | 20.89              | 9.03         |
| Tubercular meningitis.....                  | 28.72            | 36.01              | 27.26              | 11.32        |
| Other forms of tuberculosis, scrofula ..... | 20.63            | 21.20              | 17.77              | 8.90         |
| Phthisis.....                               | 7.09             | 15.17              | 34.08              | 70.75        |
| Total.....                                  | 100.00           | 100.00             | 100.00             | 100.00       |

*Deaths from tuberculosis in Berlin for the year 1898.*

[Percentage of each form.]

| Form of disease.                            | Under 1<br>year. | Under 15<br>years. | Under 25<br>years. | All<br>ages. |
|---------------------------------------------|------------------|--------------------|--------------------|--------------|
| Tabes mesenterica.....                      | 2.84             | 4.57               | 2.73               | 1.80         |
| Tubercular meningitis.....                  | 27.66            | 32.33              | 16.86              | 6.00         |
| Other forms of tuberculosis, scrofula ..... | 14.18            | 6.31               | 3.67               | 2.23         |
| Phthisis.....                               | 55.32            | 56.79              | 76.74              | 89.97        |
| Total.....                                  | 100.00           | 100.00             | 100.00             | 100.00       |

*Deaths from tuberculosis in Paris for the year 1897.*

[Percentage of each form.]

| Form of disease.                            | Under 1<br>year. | Under 15<br>years. | Under 25<br>years. | All<br>ages. |
|---------------------------------------------|------------------|--------------------|--------------------|--------------|
| Tabes mesenterica .....                     | 1.65             | 3.06               | 1.87               | 1.33         |
| Tubercular meningitis.....                  | 57.85            | 54.49              | 27.42              | 8.60         |
| Other forms of tuberculosis, scrofula ..... | 20.66            | 12.76              | 10.63              | 10.05        |
| Phthisis.....                               | 19.84            | 29.69              | 60.08              | 80.02        |
| Total.....                                  | 100.00           | 100.00             | 100.00             | 100.00       |

*Deaths from tuberculosis in New York for the year 1899.*

[Percentage of each form.]

| Form of disease.                            | Under 1 year. | Under 15 years. | Under 25 years. | All ages. |
|---------------------------------------------|---------------|-----------------|-----------------|-----------|
| Tabes mesenterica .....                     | 6.91          | 2.86            | 1.37            | 0.47      |
| Tubercular meningitis.....                  | 57.11         | 54.68           | 27.28           | 9.06      |
| Other forms of tuberculosis, scrofula ..... | 16.06         | 16.62           | 11.25           | 6.43      |
| Phthisis.....                               | 19.92         | 25.84           | 60.10           | 84.04     |
| Total.....                                  | 100.00        | 100.00          | 100.00          | 100.00    |

*Deaths from tuberculosis in Boston for the year 1900.*

[Percentage of each form.]

| Form of disease.                           | Under 1 year. | Under 15 years. | Under 25 years. | All ages. |
|--------------------------------------------|---------------|-----------------|-----------------|-----------|
| Tabes mesenterica .....                    | 2.63          | 4.35            | 2.26            | 1.14      |
| Tubercular meningitis.....                 | 56.58         | 50.87           | 23.12           | 8.31      |
| Other forms of tuberculosis, scrofula..... | 26.32         | 22.17           | 14.85           | 11.48     |
| Phthisis.....                              | 14.47         | 22.61           | 59.77           | 79.07     |
| Total.....                                 | 100.00        | 100.00          | 100.00          | 100.00    |

*Deaths from tuberculosis in Chicago for the years 1897 and 1898.*

[Percentage of each form.]

| Form of disease.                                            | Under 1 year. | Under 5 years. | Under 10 years. | Under 20 years. | Under 30 years. | All ages. |
|-------------------------------------------------------------|---------------|----------------|-----------------|-----------------|-----------------|-----------|
| Tuberculosis, mesenteric (1897) and peritoneal (1898) ..... | 1.63          | 2.47           | 2.66            | 2.55            | 1.38            | 1.04      |
| Tuberculosis, cerebral .....                                | 40.76         | 39.09          | 37.44           | 21.92           | 10.33           | 5.42      |
| Tuberculosis, other organs .....                            | 21.74         | 18.11          | 18.30           | 13.91           | 9.48            | 8.51      |
| Phthisis.....                                               | 35.87         | 40.33          | 41.60           | 61.62           | 78.81           | 85.03     |
| Total.....                                                  | 100.00        | 100.00         | 100.00          | 100.00          | 100.00          | 100.00    |

NOTE.—In these tables the term "tabes mesenterica" is believed to cover tuberculosis of the intestines, peritoneum, and abdominal lymphatic glands.

Taking England and Wales, it is seen that in children under 1 year old tabes mesenterica constitutes 46.23 per cent of the total cases of tuberculosis at that age, while phthisis constitutes but 6.98 per cent. Under 5 years the figures are 36 per cent for tabes mesenterica and 10.63 per cent for phthisis. It is not until the age of 20 years is reached that the percentage of phthisis exceeds that of tabes mesenterica. In Berlin, Paris, New York, Boston, and Chicago the statistics, however, are quite different, and the number of cases of abdominal tuberculosis returned is very much smaller.

Your committee has added a table compiled from these statistics showing the deaths per million population from the different forms of tuberculosis in England, Wales, and Scotland, and in the cities mentioned. From this table (p. 26) the extreme frequency of intestinal tuberculosis in England and Scotland is made manifest.

*Deaths per million population from different forms of tuberculosis.*

| Form of disease.                            | England and Wales, 1898. | Scotland, 1898. | London, 1898. | Berlin, 1898. | Paris, 1897. | New York, 1899. | Boston, 1900. | Chicago, 1897-98. |
|---------------------------------------------|--------------------------|-----------------|---------------|---------------|--------------|-----------------|---------------|-------------------|
| <i>Under 1 year.</i>                        |                          |                 |               |               |              |                 |               |                   |
| Tabes mesenterica .....                     | 104                      | 56              | 134           | 2             | 2            | 10              | 4             | 1                 |
| Tubercular meningitis .....                 | 63                       | 82              | 88            | 22            | 56           | 79              | 77            | 23                |
| Other forms of tuberculosis, scrofula ..... | 42                       | 29              | 63            | 11            | 20           | 22              | 35            | 12                |
| Phthisis .....                              | 16                       | 18              | 22            | 44            | 19           | 28              | 20            | 20                |
| Total tuberculosis .....                    | 225                      | 185             | 307           | 79            | 97           | 139             | 136           | 56                |
| <i>Under 15 years.</i>                      |                          |                 |               |               |              |                 |               |                   |
| Tabes mesenterica .....                     | 177                      | 185             | 200           | 16            | 19           | 11              | 18            | Under 20. 9       |
| Tubercular meningitis .....                 | 196                      | 285             | 261           | 116           | 333          | 216             | 209           | 76                |
| Other forms of tuberculosis, scrofula ..... | 108                      | 108             | 154           | 23            | 78           | 66              | 91            | 48                |
| Phthisis .....                              | 100                      | 169             | 110           | 203           | 182          | 102             | 93            | 214               |
| Total tuberculosis .....                    | 581                      | 747             | 725           | 358           | 612          | 395             | 411           | 347               |
| <i>Under 25 years.</i>                      |                          |                 |               |               |              |                 |               |                   |
| Tabes mesenterica .....                     | 186                      | 205             | 206           | 20            | 24           | 11              | 21            | Under 30. 11      |
| Tubercular meningitis .....                 | 205                      | 297             | 269           | 122           | 355          | 224             | 219           | 83                |
| Other forms of tuberculosis, scrofula ..... | 135                      | 142             | 176           | 26            | 138          | 92              | 141           | 76                |
| Phthisis .....                              | 357                      | 629             | 337           | 556           | 778          | 493             | 567           | 630               |
| Total tuberculosis .....                    | 883                      | 1,274           | 988           | 724           | 1,295        | 820             | 948           | 800               |
| <i>All ages.</i>                            |                          |                 |               |               |              |                 |               |                   |
| Tabes mesenterica .....                     | 202                      | 223             | 221           | 40            | 61           | 13              | 32            | 17                |
| Tubercular meningitis .....                 | 213                      | 303             | 278           | 134           | 398          | 243             | 234           | 90                |
| Other forms of tuberculosis, scrofula ..... | 184                      | 192             | 218           | 50            | 465          | 173             | 322           | 141               |
| Phthisis .....                              | 1,317                    | 1,668           | 1,734         | 2,009         | 3,702        | 2,258           | 2,223         | 1,406             |
| Total tuberculosis .....                    | 1,916                    | 2,386           | 2,461         | 2,233         | 4,626        | 2,687           | 2,811         | 1,654             |

The one point which it is desired to impress at this time is that abdominal tuberculosis is not so rare that it can properly be ignored and that the statistics of some countries show a remarkable number of cases.

#### POSTMORTEM EXAMINATIONS SHOWING INTESTINAL TUBERCULOSIS.

The fourth line of evidence bearing upon this question is obtained from postmortem examinations.

Koch says that among many cases of tuberculosis examined after death he remembered having seen primary tuberculosis of the intestine only twice. Among the great postmortem material of the Charité Hospital, in Berlin, 10 cases of primary tuberculosis of the intestine occurred in 5 years. Among 933 cases of tuberculosis in children at the Emperor and Empress Frederick's Hospital for Children, Baginsky never found tuberculosis of the intestines without simultaneous disease of the lungs and the bronchial glands. Among 3,104 postmortems of tubercular children, Biedert observed only 16 cases of primary tuberculosis of the intestine.

Are these selected statistics, or are the results of postmortems in Germany so different from what they are in England?

In 269 autopsies of tuberculous children, Still<sup>20</sup> determined the channel of infection with some degree of certainty in 216 cases, and in 63 of these primary infection was probably through the intestine. Carr,<sup>21</sup> in a series of 120 autopsies on tuberculous children at the Chelsea Children's Hospital, found that 16.7 per cent showed evidence of primary abdominal infection. Guthrie,<sup>22</sup> at the Paddington Green Children's Hospital, in a series of 77 cases, found evidence of primary intestinal infection in 19 cases. Shennon<sup>23</sup> collected 355 cases of tuberculosis from the postmortems at the Royal Hospital for Sick Children, Edinburgh, in 331 of which he was able to determine the channel of infection. In 28.1 per cent of these cases it was alimentary. Bollinger, in his address at the International Tuberculosis Congress at Berlin in 1899, quoted with approval the autopsies by Heller (Kiel) of 248 tuberculous children, which showed, in 45.5 per cent of the cases, tuberculosis of the mesenteric glands. From these it was concluded that milk played a leading role in the so-called transmitted tuberculosis of children.

Northrup<sup>24</sup> refers to 125 postmortems at the New York Foundling Asylum on tuberculous children, in 34 of which the bronchial nodes were large and cheesy, likewise the mesenteric nodes; the lungs contained tubercles, as did the liver, spleen, kidneys, and meninges. The primary seat of infection in these was not clear. In the remaining 91, 3 were primarily of mesenteric lymph node infection, and 88 were primarily of bronchial node infection.

G. Sims Woodhead,<sup>25</sup> in 1894, writing on channels of infection in tuberculosis, said:

I have seen in case after case in children and in animals fed on tuberculous material, the lungs markedly affected, but in a large proportion of these cases it has been possible to trace the course of invasion back from an old caseous or calcareous mesenteric gland, through the chain of retroperitoneal glands, up through the diaphragm to the posterior mediastinal and bronchial glands, and so on to the lung. I have not seen this in a few cases only, but in dozens of children, in a few adults, and in many animals.

Sheridan Delépine,<sup>26</sup> Proctor professor of pathology, Owens College, in a lecture on tuberculosis and the milk supply, said:

A very striking proof of the frequency of infection through the intestine fell under my notice 6 years ago. Dr. Simcock was investigating in my laboratory the pathology of chronic wasting of children due to improper feeding. He selected 13 cases out of many more in which there was no evidence of tuberculosis in the parents or in the various organs of the children as examined in the postmortem room. He considered these cases free from tuberculosis. I was not, however, quite convinced. We carefully examined the mesenteric glands of all these children with the object of discovering whether some might not be tuberculous. In 2 of these cases the mesenteric glands showed clear tuberculous lesions under the microscope, and in 5 more the mesenteric glands presented lesions suggesting the possibility of incipient tuberculosis. The presence of 2 clear cases of tuberculosis among 13 cases carefully selected as free from tuberculosis is specially significant.

These quotations are sufficient to make it clear that primary intestinal infection is much more frequent than is indicated by Koch's paper. After expressing himself "that a case of tuberculosis has been caused by alimenta can be assumed with certainty only when the intestine suffers first—i. e., when so-called primary tuberculosis of the intestine is found"—he first endeavors to show that such cases are extremely rare, and then proceeds to contradict his first assertion that it can be assumed with certainty to have been caused by alimenta, by saying "it is by no means certain that such cases are due to infection by bovine tuberculosis, it being just as likely that they were caused by the widely propagated bacilli of human tuberculosis which may have got into the digestive canal by some way or other, for instance, by swallowing saliva of the mouth."

It is clear that dust and bacilli inhaled with the air are deposited upon the mucous membrane of the nose, pharynx, and trachea, and that such inhaled particles must be swallowed unconsciously, as pointed out by Lord Lister in his letter to the *British Medical Journal* (August 3, 1901); also that persons infected with pulmonary tuberculosis swallowed enormous numbers of bacilli. Still it is known from postmortem examinations that pulmonary tuberculosis is more common than intestinal, and that a considerable proportion (placed by Lord Lister at one-third) of the people who die of pulmonary tuberculosis escape intestinal infection, although they are proved susceptible and have passed into their stomachs great quantities of bacilli daily for months or years. What is the explanation of this? With even the inhaled bacilli more likely to follow the digestive than the respiratory tract, why is not intestinal tuberculosis much more common than the pulmonary form?

Writers have attempted to explain this by supposing that the intestine is an unfavorable position for the bacilli to gain entrance to the tissues. Judging by the ease with which animals are infected by bovine bacilli through the digestive tract, this explanation is hardly tenable. It would appear rather that the true cause of the phenomenon is the lack of pathogenic power in the human bacillus, which has been shown experimentally on animals, and that this lack of virulence makes it difficult for human bacilli to withstand the gastric juice and other unfavorable conditions and have sufficient activity remaining to infect the body after reaching the intestine. On the other hand, the more virulent bovine germ would be more likely to maintain its activity and would be more apt to produce infection with a smaller number of germs.

The fact is that in some countries intestinal tuberculosis is comparatively rare, even with children. The statistics of Berlin, Paris, New York, Boston, and Chicago prove this, although pulmonary tuberculosis is very prevalent. Surely the air and the habitations of these

places must contain a maximum number of bacilli from the human disease. If intestinal tuberculosis is caused by such human bacilli, either inhaled or taken into the mouth in other ways, why is there not as much intestinal tuberculosis in those cities as in England and Scotland? Are British babies the only ones that swallow the inhaled bacilli? How can we explain the occurrence of 134 cases of *tabes mesenterica* per million inhabitants in children under 1 year in London as against only 2 cases in Paris, when there are more than twice as many cases of pulmonary tuberculosis per million inhabitants in Paris as in London? We see here, as in the statistics brought forward by Thorne, that there is no relation between intestinal tuberculosis and pulmonary tuberculosis; in other words, that infection by human bacilli apparently plays a very subordinate part in the causation of tuberculosis of the abdominal organs. This conclusion we think is legitimate and clearly follows from the statistics presented.

Why is *tabes mesenterica* so prevalent in Great Britain? It is a question which can properly be answered only by careful inquiry in that country. Tuberculosis is very common among the cattle there, but possibly not more so than on the continent. More attention appears, however, to be given to the inspection of meat in Berlin and Paris than in London, and possibly the same may be true of milk. Meat is more frequently eaten underdone in London, and milk is probably less frequently sterilized. In the United States we have far less tuberculosis among cattle, and also an efficient Federal meat inspection. Our milch cows do not show more than one-tenth and our beef cattle not more than one hundredth of the tuberculosis which is found in Great Britain.

Before closing this discussion your committee desires to call attention to the fact that infection of the lungs is not always the result of inhaled bacilli. There is apparently as much opportunity for bacilli taken with the food to infect the pharyngeal, tracheal, bronchial, and mediastinal glands and the lungs as there is for inhaled bacilli to infect the intestine. When all cases of pulmonary tuberculosis are cited as necessarily due to inhaled bacilli and as not by any possibility due to infection with the food, an error is committed.

G. Sims Woodhead<sup>20</sup> several years ago pointed out how frequently bacilli gained entrance through the lymphoid tissue of the tonsil, and St. Clair Thomson has recently expressed the opinion that all germs are deposited before the air reaches the larynx and that infection most probably occurs through the lymphoid tissue of the naso-pharynx and pharynx. He says: "There appears to be no justification for the generally accepted idea that the bacillus is inhaled directly into the pulmonary alveoli."



He also says of infection through the pharynx:

In many of these cases the process can be traced from the glands in the tonsil down into the neck and so on to the thorax by the mediastinal and post-sternal glands and by the intercostal lymphatics and glands, and it is interesting in such cases to note how the lungs may be perfectly healthy until the glands at their root or in the pleura have become distinctly affected.

Again he<sup>25</sup> says:

We have also an example of secondary affection of the lungs following tubercle of the pharyngeal tonsillar structures, through the glands in the neck, then those in the thorax, and finally to the lung itself, in the examples that have already been given in the infection of the pig by tuberculous milk, etc. Moreover, I have seen a similar line of invasion in children.

Koch tells us that in an experiment in which sputum was fed to 6 pigs there was no trace of tuberculosis found postmortem "except here and there little nodules in the lymphatic glands of the neck, and in one case a few gray nodules in the lungs." It appears, then, that he did get some infection in the pigs by feeding human sputum, and that the lesions, far from being in the intestines, were in the neck and lungs.

Referring to the pigs which had eaten bacilli of bovine tuberculosis, Koch says they "had, without exception, severe tubercular diseases, especially tubercular infiltration of the greatly enlarged lymphatic glands of the neck and of the mesenteric glands, and, also, extensive tuberculosis of the lungs and spleen." There is nothing said about primary tuberculous lesions of the intestines, and we are forced to the conclusion that his own postmortem notes do not sustain his contention that such lesions are essential in cases of infection through contaminated food. Lord Lister<sup>27</sup> is said to have pointed out in his reply to Koch that if primary intestinal tuberculosis were rare in children, mesenteric tuberculosis was common, and said that the interpretation seemed to him to be that the bacilli passed through the intestinal mucous membrane without causing any obvious lesion and were arrested in the glands. This interpretation seems to be accepted by most pathologists, and is certainly in harmony with the results of feeding experiments with animals. Most forms of primary abdominal tuberculosis, whether affecting the intestines, peritoneum, lymphatic glands, spleen, or liver, are, therefore, in all probability due to infection through the intestine. More than this, many cases of neck and lung infection are due to bacilli taken with the food. Ravenel<sup>28</sup> has recently said:

Dr. Pearson and I have held for a long time that food tuberculosis may appear first in the lungs or cervical glands. I have just received a letter from Dr. Pearson saying that he has killed two cows fed on tuberculosis matter, and "both had extensively tubercular lungs, and lesions nowhere else. The postpharyngeal lymph glands were normal. Neither had the slightest disease along the digestive tract." We have made similar observations repeatedly on dogs and pigs.

Observations of the same kind have been frequently made in the experiments of the Bureau of Animal Industry.

If, therefore, it is true and may be admitted that some cases of intestinal tuberculosis are caused by bacilli inhaled or which reach the saliva from the affected lung, it is also true that in even a larger number of cases the respiratory organs are infected by bacilli taken with the food. Certainly this is the case with animals, as shown by feeding experiments, and probably also with the human subject. The location of the lesions is therefore a very uncertain guide in many cases as to the channel by which the infection entered the body.

The new method of diagnosis which Koch desires us to accept—namely, the culture of the bacillus and the subcutaneous inoculation of cattle with the cultures—is yet of doubtful reliability. It has been assumed by Smith and Koch that the bacilli of bovine tuberculosis, if they produce disease in man, would retain their peculiar characteristics indefinitely, so that when isolated from the human lesions and inoculated in cattle they could be identified by their virulence for bovine animals. This is an assumption which has never been demonstrated. The method may or may not be correct, and it is only reasonable for us to decline to accept it for deciding so important a question until after its efficiency and reliability have been demonstrated. Koch says: "Hitherto nobody could decide with certainty in such a case whether the tuberculosis of the intestine was of human or of animal origin. Now we can diagnose them." It is only just to our own countryman to say that we could make the diagnosis as well after the publication of Theobald Smith's paper three years ago as we can after reading Koch's address. But the method is still in its infancy, and no one has cultivated germs known to be of bovine origin that have existed for some time in the human subject to determine whether or not they retain their distinctive properties. Bacilli from different cases of human tuberculosis differ in virulence, and the extremes of pathogenic power in such bacilli have never yet been established.<sup>a</sup> It is also true that bacilli from bovine sources differ in virulence, and here again the extremes of virulence have never been determined. Moreover, we do not know how much or how soon the bovine bacillus is modified when it propagates itself in human tissues. The experiments of Smith

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<sup>a</sup>Lartigau<sup>29</sup> has recently reported the results of interesting investigations on the range of variation of the virulence of tubercle bacilli from various classes of lesions in human beings. He concludes that tubercle bacilli of widely different virulence may exist in different cases of human tuberculosis. One specimen which he encountered presented distinctive features worthy of note. "Its growth was of very slow development, the colonies few in number, and not unlike ground glass, an appearance to which Theobald Smith has referred in connection with tubercle bacilli of bovine origin. When the extreme virulence of this tubercle bacillus for guinea pigs and rabbits is associated with the morphological and cultural peculiarities just noted, the whole closely suggests the bacillus tuberculosis of bovine derivation as described by Smith."

have opened up a wide field and lead to important suggestions but we can not yet say what conclusions will be reached by experimenting along the suggested lines.

It is to be observed that Koch does not positively answer the question as to the susceptibility of man to bovine tuberculosis, but acknowledges that it "will not admit of absolute decision to-day or to-morrow." He insists that "if such susceptibility really exists, the infection of human beings is but a very rare occurrence," and estimates "the extent of the infection by the milk and flesh of tuberculous cattle, and the butter made of their milk as hardly greater than that of hereditary transmission." This language shows his uncertainty on the great question which he has raised and bearing upon which he has offered so little evidence. If the extent of the infection from bovine sources equals that by hereditary transmission, then the danger exists, it is a real danger, and we should strive to ascertain its exact extent and how much greater it may become."

To ask the medical profession at this time to adopt sweeping generalizations on inconclusive experiments and on mere hypotheses is absurd. To expect that the definite and positive evidence from accidental inoculations, clinical observations, vital statistics, and post-mortem records will be discarded in order to adopt such hasty generalizations is ridiculous. More positive evidence will doubtless be forthcoming in the near future, as investigators will not rest until the most exhaustive researches have been made. In the end even this dramatic promulgation of a dangerous doctrine, practically unsupported by facts, will bring good to the cause of sanitation. What we must guard against is the influence of the sensationalists and of those very impressionable persons who are ever ready to accept a new doctrine which comes with the sanction of authority, no matter upon how slight a foundation of fact it rests.

In this case it is reassuring to find that the British Congress on Tuberculosis not only did not accept the doctrine, but declared that "medical officers of health should continue to use all the powers at their disposal, and relax no effort to prevent the spread of tuberculosis by milk and meat." In this conclusion your committee most emphatically concurs.

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"If it were true that man is entirely insusceptible to bovine tuberculosis, it would appear that monkeys, the animals most closely related to man, should also be insusceptible or at least should not be easily infected with bovine bacilli. An experiment of the Bureau of Animal Industry, concluded shortly after this report was presented, indicates, on the contrary, that these animals are extremely susceptible to this form of tuberculosis. A baboon inoculated subcutaneously showed an ulcer locally, great enlargement of the axillary glands, and later, symptoms of acute generalized tuberculosis. After death the lungs, liver, and spleen in particular were found filled with tubercles and other organs were more or less involved. Another monkey of a different species, inoculated at the same time, has become greatly emaciated and has probably also contracted the disease.<sup>30</sup>

## BOVINE TUBERCULOSIS AFFECTING THE PUBLIC HEALTH. (Second report.)<sup>a</sup>

By D. E. SALMON, D. V. M.,

*Chief of the Bureau of Animal Industry and Chairman of the Committee on Animal Diseases and Animal Food of the American Public Health Association.*

Your committee on animal diseases and animal food respectfully report as follows with reference to subjects which have received their attention during the time that has elapsed since the last meeting of the association:

The last report which this committee had the honor to submit discussed the important question of the relation of bovine tuberculosis to the public health, reviewed the data available at that time, and concluded that the weight of evidence was overwhelmingly against the assertion of Koch that cattle are insusceptible to human tuberculosis and that man is insusceptible to bovine tuberculosis. As anticipated in that report, numerous investigators at once instituted researches, and the results of the experiments are now being made public. Your committee feel that the question is of such general interest, and, indeed, that its elucidation is so essential to the proper performance of the duty of the sanitarian, that they venture to review it again in the light of the most recent information attainable. There are some apparent inaccuracies in the paper which Koch<sup>2</sup> read before the British Congress on Tuberculosis, to which your attention is invited. He says:

Even in my first circumstantial publication on the etiology of tuberculosis I expressed myself regarding the identity of human tuberculosis and bovine tuberculosis with reserve.

A reference to the paper which Koch mentions will show that he expressed himself as follows:<sup>31</sup>

It is not the peculiar structure of the tubercle, not its lack of blood vessels, not the presence of giant cells, that will give the solution, but rather the proof of the tuberculosis bacilli, whether it be in the tissue by means of staining reaction or whether it be by means of culture upon coagulated blood serum. This criterion being adopted as a foundation principle, according to my investigations, miliary tuberculosis, caseous pneumonia, caseous bronchitis, intestinal and glandular tuberculosis, bovine tuberculosis, spontaneous and inoculation tuberculosis of animals must be declared as identical.

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<sup>a</sup> Report of committee on animal diseases and animal food to American Public Health Association at New Orleans, La., December 8-12, 1902. Published also in Nineteenth Annual Report of Bureau of Animal Industry.

Again he<sup>31</sup> says:

The tuberculosis of domesticated animals, especially bovine tuberculosis, undoubtedly forms another source of infection with tuberculosis. By this is also characterized the position which the care of health is to occupy in the future in consideration of the harmfulness of the meat and of the milk of animals suffering with bovine tuberculosis. Bovine tuberculosis is identical with human tuberculosis, and therefore a disease transmissible to man. It is therefore to be treated just like other infectious diseases transmissible from animals to human beings. However great or small may be the danger which results from the consumption of meat or milk affected with bovine tuberculosis, it is present, and must therefore be avoided. It is sufficiently well known that meat affected with anthrax is eaten by many persons and often for long periods of time without harm, and yet no one will draw the conclusion from this that the traffic in such meat is to be permitted.

It is hardly necessary to add that the question appears to have been treated, in the paper mentioned, without any reservations whatever, and that the statements of the identity of human and bovine tuberculosis were emphatic and unequivocal. Of course, it is allowable for an author to change his views with the discovery of additional facts, but he may not cite his earlier paper in support of the later contention when the language of the earlier paper gives, as in this case, an opposite impression.

Again, with reference to the results of the earlier investigators of the subject, he<sup>2</sup> states:

If one studies the older literature of the subject, and collates the reports of the numerous experiments that were made in former times by Chauveau, Guenther and Harms, Bollinger, and others, who fed calves, swine, and goats with tubercular material, one finds that the animals that were fed with the milk and pieces of the lungs of the tubercular cattle always fell ill of tuberculosis, whereas those that received human material with their food did not.

In your committee's last report<sup>32</sup> quotations were made from Chauveau's<sup>3</sup> paper showing clearly that in his experiments cattle were successfully infected with human tuberculous material by ingestion, by intravenous injection, and by subcutaneous inoculation. From all of these experiments he concluded that the human tubercular virus acts on the bovine species exactly like the tubercular virus which comes from the bovine species itself.

Bollinger<sup>33</sup> in 1879 and Sidney Martin<sup>34</sup> in 1895 also obtained successful results with bovine animals, one by inoculation into the peritoneal cavity, the other by feeding sputum. Your committee have not been able to consult the papers of Guenther and Harms, which were also cited by Koch, but whatever their results may have been it is sufficiently demonstrated that the older investigators were not unanimous in finding that "the animals that were fed with the milk and pieces of the lungs of tubercular cattle always fell ill of tuberculosis, whereas those that received human material with their food did not." What is most striking in a review of these earlier investigations is the variability of the results. Chauveau found human as virulent as

bovine material for bovine animals. Martin found human sputum much less virulent than bovine material, while others failed entirely in the effort to infect bovine animals with human tuberculous material.

It would seem that the cause of this lack of harmony in the results of experiments of the same character should have been suggested by the researches of Vagedes,<sup>35</sup> who, in 1896, studying 28 human cultures, discovered 1 of these which was much more virulent than the others, and which was more virulent than either of 2 bovine cultures used in the investigation.

Theobald Smith<sup>36</sup> says in regard to this work:

It is somewhat remarkable that this exceptional culture of Vagedes, described in a work done under the direction of Koch himself, was wholly ignored by the latter.

Lartigau<sup>39</sup> in 1901 published results from which he concluded that tubercle bacilli of widely different virulence may exist in different cases of human tuberculosis. One culture obtained by him was extremely virulent for guinea pigs and rabbits, and had morphological and cultural peculiarities which closely suggested the bacillus tuberculosis of bovine derivation as described by Smith.

Koch<sup>2</sup> says of his experiments:

In some cases the tubercle bacilli or the sputum were injected under the skin, in others into the peritoneal cavity, in still others into the jugular vein. Six animals were fed with tubercular sputum almost daily for 7 or 8 months; 4 repeatedly inhaled great quantities of bacilli, which were distributed in water and scattered with it in the form of spray. None of these cattle (there were 19 of them) showed any symptoms of disease, and they gained considerably in weight.

For the discrimination between human and bovine bacilli he recommends the subcutaneous inoculation of bovine animals. Investigators who have since endeavored to elucidate the subject have therefore endeavored to infect animals with human material by any one or more of these methods which failed in the hands of Koch and his assistants. It is very interesting to study their results.

#### RECENT RESEARCHES WITH REFERENCE TO THE COMMUNICABILITY OF HUMAN TUBERCULOSIS TO ANIMALS.

Ravenel,<sup>37</sup> of the Pennsylvania Live Stock Sanitary Board, and a member of this committee, in 1898 fed 4 calves with human sputum. Postmortem examination proved that all had become affected with tuberculosis, the lesions in 2 being quite extensive. In March, 1901, he obtained material from the mesenteric glands of a child which died of tubercular meningitis. The bacilli from this material have proved very virulent for bovine animals. One calf inoculated intravenously with a suspension of a culture of this bacillus showed marked illness during life and died in 17 days. Both lungs were found thickly studded throughout with miliary nodules. The bronchial and mediastinal

glands were much enlarged and soft, the former showing small areas of caseation. The liver was soft and friable, and several nodules were visible on its surface.

A second calf was inoculated into the peritoneal cavity with a similar suspension of a culture of this bacillus. This animal died in 27 days, after showing an abnormally high temperature from the eighth day. It was greatly emaciated, having lost 37 pounds in weight. The central and posterior portions of the lungs showed many areas deep in color and solid to the feel. These were thickly studded throughout with minute grayish nodules. The suprasternal lymph glands were as large as goose eggs, and contained cheesy areas. The mediastinal glands were much enlarged. The peritoneum was everywhere enormously thickened and practically converted into a tuberculous mass. The omentum and liver contained many nodules.

A cow was inoculated intravenously with only 2.5 c. c. of a suspension of a similar culture and died in 17 days. The lungs were thickly studded throughout with miliary nodules.

A second culture obtained from the mesenteric glands of a child, and which in its manner of growing and microscopical appearance led the investigator to consider it a typical human culture, was found to be unexpectedly virulent when tested upon dogs. A calf inoculated intravenously with suspension of a culture was killed on the forty-sixth day, death then appearing imminent. The anterior lobes of both lungs were thickly studded with minute nodules averaging 1 mm. in diameter. The bronchial and mediastinal glands were enlarged, and scrapings from the cut surfaces showed an enormous number of tubercle bacilli. Many yellow nodules were seen in the mediastinal glands. In the liver were many minute nodules, sections of which showed large numbers of tubercle bacilli. The spleen showed round-cell infiltration, giant cells, and many tubercle bacilli. There were also white areas in the kidneys with round-cell infiltration and many bacilli.

In the Bureau of Animal Industry a number of virulent cultures of tubercle bacilli have been obtained from human sources. A few of these are worthy of notice in this connection. De Schweinitz,<sup>30</sup> of the Biochemic Division of the Bureau of Animal Industry, isolated a tubercle bacillus from a mesenteric gland of a child affected with tubercular peritonitis. This bacillus, when grown on egg medium, corresponded to the bovine type. A calf received intravenously 5.5 c. c. of a suspension made from an egg culture. This animal died in 20 days of generalized tuberculosis. The lungs were a mass of small tubercles, while the bacilli were demonstrated in the liver, spleen, kidneys, and mesenteric and mediastinal glands. The same investigator obtained a culture from another child affected with peritoneal tuberculosis. This culture also corresponded to the bovine type

when grown on egg medium. A calf inoculated intravenously with 5 c. c. of a suspension of egg culture died in 17 days. The autopsy showed generalized tuberculosis, numerous bacilli being demonstrated in the lung, liver, spleen, and mediastinal glands. A steer was inoculated subcutaneously with a piece of tuberculous tissue from this child. The animal was killed at the end of 6 months, and the autopsy showed the flank and shoulder glands enlarged, caseous, and calcified. There were numerous excrescences upon the border of the lung and upon the pleural surface of the diaphragm. Bacilli were demonstrated in these excrescences and also in the glands. Both of these cultures are therefore very virulent for bovine animals when given by intravenous inoculation, and one at least is virulent when injected subcutaneously.

A calf previously tested with tuberculin, as was done with all the larger animals used in these experiments, was inoculated subcutaneously in the side of the neck with 5 c. c. of a suspension of a culture of this bacillus. This animal presented the ordinary signs of tubercular infection, and, being emaciated, weak, unable to rise, and in a dying condition, was killed on the thirty-first day. The autopsy showed generalized tuberculosis. The prescapular gland and mediastinal glands were enlarged and tubercular, the lungs were filled with tubercular nodules, and the liver was affected to an almost equal extent. The omentum showed many tubercular nodules and the kidneys a small number.

Mohler,<sup>38</sup> of the Pathological Division of the Bureau of Animal Industry, has obtained three cultures of bacilli from human sources which, because of their virulence for the species of animals on which they have been tested, are also worthy of mention. One of these, which had its source in the mesenteric gland of a girl who died of tuberculosis, appears more virulent for goats and cats than the first culture of Ravenel above mentioned. A goat inoculated subcutaneously was in poor condition and growing thinner at the end of 137 days. A cat inoculated in the same manner died in 104 days of pulmonary tuberculosis. A rabbit was in poor condition at the end of 137 days. The bacilli cultivated in dog serum averaged 2  $\mu$  in length, some slightly curved and beaded. This bacillus was of the human type, but when recovered from the cat it was markedly reduced in length and slower in growth.

Another bacillus obtained from the mesenteric gland of a boy affected with tuberculosis is shorter, averaging from 1.2 to 1.5  $\mu$ , is beaded, and grows rapidly and luxuriantly. A goat inoculated subcutaneously with this culture died in 37 days with miliary tuberculosis of the lungs, involving the axillary and prescapular glands. A dog inoculated in the same manner after 59 days was thin and becoming emaciated, and had an ulcer at the point of inoculation. A cat similarly inoculated was in poor condition at the end of 59 days. The



third germ, obtained by Mohler, is particularly worthy of attention, because it was isolated from human sputum. It is, when grown on dog serum, 1.7 to 2.2  $\mu$  in length, slender, beaded, and curved. A goat inoculated subcutaneously died in 95 days of pulmonary tuberculosis. There were also tubercular lesions at the point of inoculation and in the prescapular gland. A cat inoculated subcutaneously died in 23 days of generalized tuberculosis. A rabbit inoculated in the same manner died in 59 days of pulmonary tuberculosis. A bovine culture was used for comparison with the cultures just described and killed a goat in 55 days, as compared with 37 days for the second human culture and 95 days for the third human culture. The bovine germ also killed a rabbit in 69 days as compared with 59 days for the third human culture. This work also shows that it is not a difficult matter to obtain very virulent tubercle bacilli from human sources, and that some of these are just as virulent as bovine bacilli.

At the British Congress on Tuberculosis, Thomassen<sup>39</sup> reported an experiment in which a calf was inoculated in the anterior chamber of the eye with a pure culture of a tubercle bacillus isolated from a case of tuberculous arthritis in man. When killed after 6 weeks, it was found that both lungs contained numerous miliary tubercles and some gray fibrous tubercles of larger size. The path of infection from the eye to the lung could be traced by the condition of the sub-parotideal, cervical, mediastinal, and bronchial lymph glands of the same side.

De Jong<sup>40</sup> reports, as a result of a series of inoculations, that 7 bovine animals, namely, 2 calves 6 months old, 3 steers 2 years old, 1 18 months, and 1 calf 7 or 8 months old, all became tuberculous by the injection of tubercle bacilli of human origin. Consequently all the bovine animals used in the experiment were infected by human bacilli. The disease produced was serious and very extended in only 1 animal, with 4 others it had a retrogressive tendency, and in the 2 remaining cases it was progressive. He concludes that these results demonstrated that bacilli isolated from the human body or from sputum are capable of causing tuberculosis of cattle.

Delépine<sup>41</sup> recently stated, in a discussion on the relationship of human and bovine tuberculosis, that he had been able to obtain from the human subject bacilli just as virulent as the bovine tubercle bacillus, but in most the human tubercle bacillus was less virulent.

Orth<sup>42</sup> made experiments with 3 calves, 3 hogs, and 3 goats. The infectious material was obtained from a case of phthisis cavernosus by inoculating a guinea pig and then obtaining cultures from this animal from brain and other media. In the experiments bouillon cultures of the organism were used, and in some cases tuberculous organs from rabbits. One calf inoculated into the lung through the trachea gave an entirely negative result. The second, inoculated between the

abdominal muscles, showed only a local caseous abscess. The third, which was inoculated in the peritoneal cavity with two pieces of tuberculous kidney from a rabbit, died on the twenty-sixth day of a general tuberculous peritonitis. The serous membranes were covered with miliary and submiliary tubercles. The great omentum had nodules scattered throughout and small nodules were visible on the serous membrane of the intestine. The mesenteric portal and retrosternal lymph glands were much enlarged and showed gray and white nodules upon section. There was no doubt but that a progressive fatal tuberculosis was produced in this calf by material originating in the human subject.

Of the 3 pigs, 2, which were inoculated intraperitoneally with the bouillon culture, gave negative results. The third, inoculated through the trachea into the lungs, was killed after 5½ months and a large number of miliary and submiliary tubercles were found in the inferior lobe of the right lung, and there were many yellowish tuberculous nodules in the thymous gland and in the membranes around it. One of the goats inoculated through the trachea into the lung with the bouillon culture showed a number of subcutaneous nodules near the point of inoculation, a large caseous nodule in the thymous gland, and a number of yellowish gray nodules in the inferior lobe of the right and left lungs. The second goat was inoculated intraperitoneally with a small piece of lung from a tuberculous rabbit. The animal was killed after 5 months and a number of nodules were found in the muscles and subcutaneous tissue at the point of inoculation. There were also a number of small, grayish translucent nodules scattered through the omentum, on the diaphragm, and in the neighborhood of the lymph glands; a nodule about the size of a pea was found on the anterior border of the liver. The third goat was inoculated with a piece of tuberculous spleen the size of a pea placed in the peritoneal cavity. On autopsy a number of tubercles were found around the point of inoculation. There was a large group of caseous nodules on the adjoining surface of the stomach and numerous caseous nodules in the omentum, many of these latter having small pedicles. Tubercle bacilli were easily demonstrated, and there was no doubt as to the tuberculous character of the lesions nor that they were produced by human tubercle bacilli.

Stenström<sup>43</sup> inoculated 8 calves in various ways with tuberculous sputum rich in tubercle bacilli. Of these, the following showed positive results: No. 224 was inoculated intraperitoneally with 5 c. c. sputum. When killed, after 6 months, the autopsy showed many calcified nodules upon the omentum and an enlargement of the glands connected therewith. Many miliary tubercular foci were present in the liver, and the posterior lobe of the right lung showed hypertrophy of the connective tissue on its serous cover. No. 820 was inoculated in the lungs with 20 c. c. When killed, after 4 months, it showed many tubercular growths on the costal and diaphragmatic pleura, and

tubercular nodules in two mediastinal glands. No. 883 was inoculated intratracheally on October 8 with 6 c. c. and on November 8 with 10 c. c. of sputum; was killed March 17 and showed partially calcified nodules in the posterior and anterior mediastinal glands and also in the bronchial glands. Stenström disagrees with Koch and states that he found it quite easy in his experiments to infect cattle with human tuberculosis.

Fibiger and Jensen<sup>44</sup> attempted to answer the question as to the intercommunicability of human and bovine tuberculosis by selecting from the various hospitals of Copenhagen those cases of tuberculosis in which the autopsy indicated a primary intestinal infection. They report in all 5 cases of tuberculosis in the following subjects: (1) A 42-year-old woman, (2) an 11-year-old girl, (3) a 6-year-old boy, (4) a 19-months-old girl, and (5) a 4-months-old boy. A 3-months-old calf was inoculated in the thoracic cavity with a suspension made from a mesenteric gland of case No. 1. This calf remained apparently in good condition and was killed at the end of 6 months. Two miliary tubercles and a few fresh pearl nodules were found on the pleura. A 3-months-old calf was inoculated with a suspension made from the spleen of a guinea pig which had been inoculated with a mesenteric gland from case No. 2. When killed, at the end of the fifth month, there were found a large number of small red growths and about twenty small fresh pearl nodules on the omentum. On the diaphragm there were some small nodules and excrescences and one small excrescence on the pulmonary pleura. A calf was inoculated intraperitoneally with a suspension made from the spleen of a guinea pig which had been inoculated from case No. 3. When killed, after about 5 months, the omentum was found filled with tuberculous growths and showed countless small nodules of varying size. There were some small nodules found on other portions of the peritoneum and the surface of the spleen, liver, and diaphragm was covered with small pearl nodules. A calf was inoculated subcutaneously on the right side of the neck with a suspension made from a mesenteric gland of case No. 4. When killed, at the end of the third month, there was a large caseous mass at the point of inoculation; the neighboring glands were large, caseous, and calcified; the lungs had scattered through them many small miliary nodules, and there were a number of excrescences attached to the pulmonary pleura. The bronchial and posterior mediastinal glands were enlarged, hard, and contained fresh, caseous, and calcified nodules. On the surface of the liver there were 10 small pearl nodules. Miliary tubercles were scattered through the liver and spleen, and the omentum was filled with fine, diffused, red new growths.

Two 10-days-old calves were inoculated subcutaneously on the side of the neck with a suspension made from a mesenteric gland from case No. 5. Both of these animals died within 3 weeks from secondary

infection. Nevertheless, there developed a considerable local tuberculosis rich in bacilli. From calf No. 2 a third calf was inoculated subcutaneously on the right side of the neck. A large abscess formed at the point of injection, and the calf, being in a dying condition, was killed at the end of about 2 months. The autopsy showed, in addition to the local lesions, tuberculosis of the adjacent lymph glands, with many new growths on the costal and diaphragmatic pleura and a few on the pulmonary pleura. The lungs contained a countless number of small nodules, in some portions so close together that the air was practically absent. The bronchial and mediastinal glands were enlarged and caseous; the liver, spleen, and kidneys had miliary tubercles scattered through them. The intestinal wall was very rich in fresh nodules and small superficial ulcerations. The mesenteric glands were enlarged and tuberculous. The omentum was rich in small new growths. A cow about 10 years old was inoculated on the left side of the neck with material from calf No. 1 and developed an abscess at the point of inoculation. When killed, at the end of 4 months, in addition to the local abscess, the neighboring glands were enlarged, caseous, and calcified. Miliary tubercles were scattered through the lungs, a nodule the size of a pea was found in the posterior mediastinal gland, and a small number of miliary tubercles in the liver. The authors say that it is thus seen that in the 3 cases of tuberculosis in children the bacilli present were virulent, some of them in the highest degree for calves, and it is probable that the disease in children was caused by bacilli which came from cattle. In the 5 cases there were found bacilli having the greatest variation in virulence for calves, from those which were entirely avirulent to those which were slightly virulent, virulent, and of the highest virulence. They conclude by stating that Koch announced that one could distinguish between human and bovine tuberculosis by inoculating calves subcutaneously. If this is true, then they are of the opinion that 3 of the cases just cited must be considered as "perlsucht," and the idea that tuberculosis of cattle is not virulent for men is disproved.

Max Wolff<sup>45</sup> reports inoculations from a case of primary tuberculosis of the intestines in man which he considers fully meets all the requirements demanded by Koch for the experimental solution of this uncommonly important question. Two guinea pigs were inoculated with diseased spleen. Seven or 8 weeks afterwards they gave unmistakable evidence of being tuberculous, and were in consequence killed. In each animal both lungs were studded with nodules of the size of a pin head; the liver contained numerous submiliary nodules, and a swollen, cheesy gland was located at the hilus of this organ. The spleen was studded with nodules, many of them exceeding the size of a pin head. A calf was inoculated in the side of the neck with 12 c. c. of sterilized water in which bits of a lung and spleen from

the guinea pig had been macerated. Microscopic examination of this material showed tubercle bacilli to be present in very scanty numbers. Eighty-three days after inoculation the calf was killed. It had become considerably emaciated. The autopsy revealed very severe changes at the point of inoculation and characteristic pearl disease in the internal organs. Upon the surface of the pleura were numerous pedunculated tumors ranging in size from a flaxseed to a cherry, and between these were hyaline miliary tubercles. The lungs showed many grayish tubercles, and the pericardium was covered with them. The mesentery contained countless small tumors, many of them pedunculated. The capsule of the spleen was studded, and the liver showed numerous miliary tubercles in its pulp and on its capsule. Each kidney bore 5 or 6 grayish tubercles the size of flaxseed upon its outer surface. The virulence of the germs isolated from this calf was further proven by inoculations upon the guinea pig. The author thinks that it is here proven that pearl disease of cattle may appear in man.

Nocard<sup>46</sup> states that cattle are not refractory to human tuberculosis and that it is easy to give the proof of this. If they are inoculated in the arachnoid cavity with a few drops of a feeble culture of the human bacillus they succumb in less than a month, and the autopsy reveals lesions of tuberculous meningitis absolutely identical with those of children. A calf 5 months old inoculated in this way August 2 succumbed August 28. A portion of its pia mater, infiltrated with tubercles, killed in 6 weeks the guinea pig which received it in the peritoneum.

Arloing<sup>47</sup> reports experiments with three different cultures of human origin. One of these had been in his laboratory since 1896. It was capable of infecting guinea pigs and rabbits by subcutaneous inoculation. He inoculated by intravenous injection with an emulsion of this culture a heifer, a young calf, 2 sheep, and a kid. He says that on autopsy the calf and the sheep presented a superb eruption of tuberculous granulations in all parts of the lung, principally in the anterior lobe. With the kid the lesions were more diffuse, and so extensive that the lungs scarcely collapsed when removed from the thorax. The heifer showed signs of pleural disease, for very marked excrescences were found on the borders of the lung and on their diaphragmatic surface. A small number of tubercles were found scattered through the lung. With the second culture he inoculated intravenously a calf, 2 sheep, and a goat. The autopsy demonstrated the existence of tuberculosis of the lungs in all of these animals. With the calf there were found a multitude of small young tubercles, and the subpleural granulations slightly raised in the serous membrane were easily seen. With the sheep the lungs had but little tendency to collapse. There were many subpleural granulations and

small tubercles throughout the parenchyma. With the goat the lesions recalled those found with the sheep, but were less confluent. With an emulsion of the third culture he inoculated a young bull, 2 sheep, and a goat by intravenous injection. The bull died at the end of 32 days. It was considerably emaciated, having lost 35 kilograms. The anterior and median lobes of the two lungs were studded with tubercles of various sizes, the largest being the size of a millet seed. The bronchial and esophageal glands were enormous, weighing 400 grams. In the lungs of the sheep there were perceived by the touch an enormous number of small subpleural tubercles. On section there were also seen many tuberculous granulations in the depth of the parenchyma. With the goat the lesions were similar to those found in the sheep, except the granulations were smaller.

Behring<sup>48</sup> reports an experiment in which human sputum was injected into a guinea pig and a culture from this animal's spleen was used for inoculating a goat. An emulsion of the spleen of the goat was passed through a series of guinea pigs, and a culture obtained from the spleen of the third guinea pig was inoculated into a calf by intravenous injection. The calf died after 4 weeks, directly from the tuberculosis thus produced. At the autopsy the lungs were found in the red stage of hepatization. From these organs tubercle bacilli were recovered in large numbers. A fairly numerous collection of subpleural nodules were present, which were yellowish in color and had reached in some instances the size of peas. Tubercle bacilli were recovered readily from these nodules. The bronchial glands were swollen and tubercle bacilli were proven present within them. The liver contained fatty infiltrations, and the spleen was darkened, but scarcely enlarged. Tubercle bacilli were recovered from it, but were not numerous. The pronounced malignity of the virus in this instance is worthy of particular notice, because it concerns bacilli derived from human sputum, although they had been passed through the goat. A cow was also inoculated with a tuberculosis culture of human origin after a single passage through a guinea pig. The inoculation was made intraocularly on November 26, 1901. On January 14, 1902, the affected eye was enucleated and a pure culture was obtained from it after one passage through a guinea pig. The cow did not die at once as a result of the inoculation, but has been gradually losing ground, and was at the time the report was made in a condition of chronic disease so serious that the final outcome could not be foretold.

Dean and Todd,<sup>49</sup> who have recently carried out certain experiments to ascertain whether the tubercle bacillus of human origin undergoes any marked change in virulence for the bovine species by passage through certain other animals, say that "the experiments show that the human tubercle bacillus is by no means innocuous to the calf, as the control animal injected directly with sputum contracted an

extensive glandular tuberculosis;" also, "as mentioned above, with reference to the infection of the pig, an important result was obtained, as the experiments conclusively prove that this animal is capable of contracting a rapidly fatal general tuberculosis as the result of inoculation with the tubercle bacillus of human origin."

These investigations are now sufficiently numerous and sufficiently harmonious in their results to establish the following conclusions:

(1) The bacillus tuberculosis found in human tuberculosis differs greatly in its pathogenic powers as obtained from different cases.

(2) Two types of tubercle bacilli may be obtained from man, namely, one which is somewhat difficult to cultivate, which grows slowly, and the bacilli of which are short, stubby, and free from beading—the so-called bovine type; and a second, which is quite easily cultivated, grows rapidly, is longer, thinner, and inclined to show beaded and curved forms—the so-called human type.

(3) Virulent cultures may be obtained from both of these types, which, when inoculated according to the methods used by Koch and upon the species of animals specified by him, produce progressive and fatal tuberculosis.

(4) The contention that human tuberculosis can not be transmitted to asses, sheep, goats, hogs, and especially to cattle, has been completely disproved.

(5) Koch's failure to produce tuberculosis in the animals named with bacilli from human sources was probably due to the use of bacilli of low pathogenic power.

#### THE TRANSMISSION OF BOVINE TUBERCULOSIS TO MAN.

Some interesting observations have also been made during the year with reference to the transmission of bovine tuberculosis to man. Krause reports the case of a laborer who was brought to the clinic in order to ascertain whether the trouble in his right arm was due to infection, and, if so, of how long standing. The man stated that he was a butcher, whose duty it was to remove the diseased parts of cattle killed for food. Three years previously he ran a splinter of wood from a table into his right thumb, and immediately afterwards removed the hide from a cow that had been sick. Soon his arm swelled and pained him; later it was covered with discharging ulcers of various sizes. Incisions were made in the arm, but without causing complete healing; afterwards larger incisions were made, which were successful. Pieces of gland and skin from the arm proved on examination to be tuberculous. According to the man's statement, he is of a healthy family, 30 years old, and had not previously suffered from disease. The lungs were sound, as were all the other internal organs, and his mind was clear. The reporter thinks there is no doubt whatever that this was

a case of inoculation tuberculosis traceable directly to the splinter wound on the thumb.

Ravenel<sup>50</sup> reported, in his address at the British Congress on Tuberculosis, the case of his assistant, who was inoculated with bovine tuberculosis, and from whose tissues bacilli were recovered after 58 days which retained the activity of the original bovine virus.

Quite recently Spronck and Hoefnagel<sup>51</sup> recorded the following case: In May, 1900, a veterinarian accidentally wounded with a knife the finger of a butcher who was assisting him in inspecting the tuberculous organs of a cow. The wound healed promptly, but was followed in a few days by tumefaction and the formation of cracks in the skin. The skin of the finger became thickened and blue in color and the cracks covered with little scabs. In February, Professor Nareth extirpated the affected portion of the skin, together with the tumefied cubital ganglia. The tuberculous nature of the cutaneous lesions, as well as that of the hypertrophied ganglia, was easily recognized both by microscopic examination and by the inoculation of guinea pigs. A calf previously tested with tuberculin was placed in a newly constructed stable, in which no animal had been kept, and inoculated with an emulsion made from the spleen of one of these guinea pigs. Five days after the inoculation a swelling was noticed, and in a few days the superficial cervical ganglia were visibly tumefied. The animal soon exhibited constitutional symptoms, remained lying down most of the time, and drank excessively. The swelling increased rapidly and the animal was slaughtered 57 days after the inoculation. At the autopsy there was found at the point of inoculation on the right side of the neck a tuberculous granuloma the size of a fist inclosing at its center a large cavity filled with a soft, cheesy mass. The neighboring superficial ganglia were found granulomatous, hypertrophied, and hard. The pleura and the visceral folds presented numerous tubercles, varying in diameter from 1 to 6 mm. The tissue of the lungs was also the seat of numerous tubercles of similar size, each showing an inflammatory areola. The bronchial and mediastinal glands were hypertrophied, and on section showed caseous, noncalcified contents. Similar conditions were found in the organs generally throughout the body. Microscopic examination demonstrated that the tuberculous foci contained abundant giant cells and numerous tubercle bacilli. Finally, 2 guinea pigs which had been inoculated with material from the hypertrophied cervical ganglia—1 in the peritoneum and the other beneath the skin—died of tuberculosis. The bacilli had consequently retained their virulence for a period of 20 months, during which they lived in human tissues. These observations, according to the authors, leave no doubt as to the possibility of the infection of man with bovine tuberculosis, and they



hold that cases of contagion from the use of milk, butter, and meat of tuberculous cattle are not so rare as Koch and Baumgarten maintain.

Lassar<sup>52</sup> was impelled by Koch's statements to examine closely the records of his patients during the past decade to determine how many of those that were suffering from verrucose tuberculosis of the skin of the hands could have been infected by means of injuries received in handling tuberculous meats. He found 34 cases of tuberculosis following wounds in 108,000 patients, but only 4 of this number were butchers. He later questioned and examined 365 men who were employed in abattoirs, and found 7 suffering from inoculated tuberculosis, while 3 others must be considered as possibly affected. This shows 2 to 3 cases to each 100 men employed in the abattoirs, and only one-third of 1 per 1,000 among persons otherwise employed.

Hüls<sup>53</sup> reports a case of a miller's family in good circumstances near Manderschied, composed of the miller, his wife, five sons, and two daughters, all herculean in stature and boastful of strength and health. Consumption had never occurred in the families of either of the parents. The mother became affected with pulmonary catarrh, which aroused a suspicion of tuberculosis, but after a few months she was again healthy. During the following year the 13-year-old daughter became ill of pulmonary tuberculosis and died. The same year an 18-year-old son died, and the following year a 23-year-old son. Two years after her first illness the mother sickened and died; then followed the death of a 16-year-old daughter, then the father, and finally the third son, all of pulmonary tuberculosis. For one of the two remaining sons a tuberculous abscess of the finger was treated, which healed. These two men are still living. Hüls thinks that the view of contagion from the sick members of the family can not be held, since there was practically no contact. These cases appeared subsequently to the introduction by the miller of a herd of Simmenthal cattle on his farm. These cattle were all practically infected with tuberculosis, and it was scarcely possible to dispose of the meat on account of its infected condition. Many of the carcasses were returned on account of being tuberculous, so that later the owner was compelled to sell the cattle without a guaranty as to their condition.

Considering these facts, in connection with those of similar bearing previously reported, it may be said that the transmission of bovine tuberculosis to man is fairly well established. The apparent inoculation of a human subject with bovine tubercular material, the development of a tubercular process at the point of inoculation, the isolation from the human tissues months afterwards of a tubercle bacillus having the characteristics of the bovine bacillus, constitute a chain of evidence that is conclusive.

## INVESTIGATIONS BEARING UPON INTESTINAL INFECTION.

Heller<sup>54</sup> has made an investigation as to the comparative frequency of primary intestinal tuberculosis. He says that it is well known that tuberculosis frequently appears after diphtheria, and he therefore investigated to determine first how often tuberculosis was present before the attack of diphtheria, and, second, how often the primary lesions were located in the intestine.

Sections were made from 714 victims of diphtheria, and among these 140, or 19.6 per cent, were found to have an associated affection of tuberculosis in various organs.

2, or 1.43 per cent, showed primary intestinal tuberculosis.

8, or 5.7 per cent, showed primary intestinal and mesenteric gland tuberculosis.

33, or 23.5 per cent, showed primary mesenteric gland tuberculosis.

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43, or 30.7 per cent, of all the tuberculosis cases.

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43, or 6 per cent, of all the diphtheria cases.

10, or 7.1 per cent, had mesenteric gland tuberculosis, with affection of other abdominal organs.

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53, or 37.8 per cent, of all tuberculosis cases.

53, or 7.4 per cent, of all diphtheria cases.

In addition to these, there were 6 other cases affected with tuberculosis of the intestines or of the mesenteric glands, together with a tubercular affection of the lungs.

With 30.7 per cent of so many tuberculosis cases showing primary lesions in the intestines or mesenteric glands, the argument against infection by ingestion of tuberculous food which was raised by Koch and based upon German statistics appears to be greatly weakened.

Gottstein,<sup>55</sup> in a recent statistical study relative to the etiology of tuberculosis, concludes that among children in Berlin the mortality of those at the breast is but slightly more than half as much from tuberculosis as among those otherwise nourished, the proportion, as he finds it, being as 6 to 10. He also finds, in studying the statistics of 23 large cities and university cities, where the returns are especially reliable, that whereas there has been a reduction of the mortality at all ages from tuberculosis, this reduction has been distinctly less in children under 15 years of age than in persons over that age. From this he concludes that "the thought is not to be set aside that in the etiology of tuberculosis in children and in grown people very important differences must occur. There must be assumed for the infection of children another source than for that of grown people, and it certainly is natural to conclude from the difference established statistically that the source of children's tuberculosis is to be sought partly in nourishment with milk containing tubercle bacilli, while the decrease since

1894 is to be traced back to the better general and individual prophylaxis in the care of milk."

An examination of the vital statistics of Massachusetts and Michigan, the only States from which sufficiently complete records were received, indicates a tendency of the same nature in the development of tuberculosis in the United States. In the Vital Statistics of Massachusetts, 1853-1895, the 2 years 1856-1857 are contrasted with the 2 years 1894-1895. In the 2 years first mentioned, for the period under 5 years of age, there were 46.3 deaths from pulmonary phthisis to 1,000 deaths from all causes. In the 2 years last mentioned there were but 15.6 deaths from pulmonary phthisis to 1,000 deaths from all causes, or one-third as many. This is a very gratifying reduction in the phthisis death rate. Let us see, now, how it is with other forms of tuberculosis. In the 2 years first mentioned there were in the same age class 70.7 deaths from other forms of tuberculosis to each 1,000 deaths from all causes; and in the 2 years last mentioned there were 96.2 deaths from other forms of tuberculosis to each 1,000 deaths from all causes. That is, in this 40 years there appears to have been an increase of 36 per cent in the forms of tuberculosis other than phthisis in the class under 5 years of age, while there was a reduction in the mortality of phthisis at all ages of about 45 per cent. The vital statistics of Michigan show that in that State during the years 1870 to 1884, inclusive, taking the class under 5 years of age, there were for each 100 deaths from consumption 81.8 deaths from other forms of tuberculosis; during the years 1885 to 1897, inclusive, there were 104.3 deaths from other forms of tuberculosis to each 100 from consumption, while during the 3 years 1898 to 1900, inclusive, there were 263.3 deaths from other forms of tuberculosis to each 100 from consumption. Why this tremendous increase in mortality from other forms of tuberculosis as compared with consumption at what has well been called the milk-drinking age of life?

Another important question which was discussed by your committee in its last report has reference to the possibility and frequency of tubercular infection through contaminated food when the primary lesions are elsewhere than in the abdominal cavity. The frequency with which infection may occur through the walls of the upper air passages, and particularly those of the naso-pharynx and pharynx, was shown. From recent experiments it appears that there is very likely another channel by which such infection may readily occur. It is a common observation that tubercle bacilli may penetrate the intestine and produce tubercles in the mesenteric glands without causing any lesions at the point where they pass through the intestinal wall. It has been frequently held, however, that they could not enter the thoracic duct and the blood vessels without first passing through and being arrested by a lymphatic gland.

Dobroklonski<sup>56</sup> in 1890 conducted some investigations from which he concluded that tuberculosis may certainly affect the organism by the digestive tract. For this infection to occur it is not necessary that there should exist a lesion of the intestinal wall, an epithelial desquamation, nor any local modification whatever, nor an interior inflammatory process. The tubercular virus (bacilli as well as spores) may easily traverse the completely normal epithelial lining of the intestine. The tubercle bacilli as well as their spores, unless they remain a long time in contact with the intestinal wall, are not capable of causing inflammatory processes in this wall, nor modifications of the epithelial coat.

In 1895, Desoubry and Porcher<sup>57</sup> made investigations with dogs to learn if microbes of various kinds may pass through the intestinal wall and enter the thoracic duct. They took chyle directly from the cistern of Pecquet, and also blood from the portal vein. In both cases they demonstrated the presence of bacteria. The species were not determined, but they observed cocci, bacteria, and bacilli. They say, in conclusion, that it seems to follow from their experiments that microbes may follow the lumen of the chyle vessels. Every time that the animal received either fat or milk they constantly found bacterial species in the chyle. They ask, May we not infer from this that the microbes pass into the chyle vessels by means of the globules of fat?

Quite recently Nicolas and Descos<sup>58</sup> have experimented in a similar manner after feeding tubercle bacilli to dogs. These investigators fed a soup composed of from 1 to 1½ liters of milk, according to the size of the animal, from 80 to 100 grams of fat, and about 100 grams of bread to dogs which had fasted 24 to 36 hours. The animals were killed from 3 to 3½ hours later. The chyle for examination was taken from the cistern of Pecquet or the thoracic duct. After each experiment a complete autopsy was made to assure the authors that the animal did not possess any tuberculous lesion and that the intestine was perfectly normal. The presence of tubercle bacilli was demonstrated by the coloration of the microscopic preparations and by the inoculation of guinea pigs. Positive results were obtained by both methods. The authors conclude as follows: The essential fact brought out by these experiments is that 3 hours after the ingestion of tubercle bacilli the chyle and the lymph of the thoracic duct may contain bacilli and even virulent bacilli in a sufficient number to cause tuberculosis in the guinea pig. They think it quite interesting to know that this may occur under conditions which approach quite closely those of a child fed with tuberculous milk.

To recapitulate, recent investigations show that—

(1) While the bacilli of human tuberculosis are often of feeble virulence for cattle, there is a considerable proportion of cases in which these bacilli are virulent for cattle as well as other animals.

(2) Bacilli of both the bovine type and the human type have been obtained from cases of human tuberculosis.

(3) Bovine bacilli introduced into the human tissues by accidental inoculation have lived, multiplied, and produced disease at the point of inoculation, and have been recovered after a considerable time with their vitality and virulence unimpaired.

(4) Various statistical studies indicate that a considerable proportion of the cases of human tuberculosis, and particularly with children, originate through the ingestion of the bacilli with contaminated food.

It appears to your committee, therefore, that the conclusions of Koch, announced at the British Congress on Tuberculosis, to the effect that bovine and human tuberculosis are different, that human tuberculosis can not be conveyed to cattle, and that man is insusceptible to bovine tuberculosis are disproved and should no longer have weight with sanitarians. The evidence brought forward indicates that greater care should be exercised to prevent human infection with bovine tuberculosis, and particularly to guard children from tuberculous milk.

## BOVINE TUBERCULOSIS AFFECTING THE PUBLIC HEALTH. (Third report.)<sup>a</sup>

By D. E. SALMON, D. V. M.,

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Your committee on animal diseases and animal food have the honor to make the following report with reference to tuberculosis, and regret that the time at the chairman's disposal has not permitted the inclusion of other subjects which are also of great interest at this time.

In the last two reports presented by this committee considerable space was devoted to the subject of tuberculosis, and particularly to that phase of it which relates to the transmission of the disease from animals to man. It was shown from a review of the facts obtained by different methods of inquiry that the clinical evidence, the evidence of statistics, and the evidence from experimental researches all favored the conclusion that animal tuberculosis was a factor in the causation of human tuberculosis, and it was held that sanitarians should advocate and enforce measures to prevent the transmission of the disease from animals to man. This question is so important and so much uncertainty has been caused by the paper presented at the British Congress on Tuberculosis by Koch,<sup>2</sup> and by his subsequent address at the International Conference on Tuberculosis at Berlin,<sup>59</sup> that it is deemed advisable to continue the discussion in the present report.

The fact that tubercular material from human subjects often failed to produce serious disease in cattle was observed by a number of the earlier investigators who experimented with such virus. It was the experiments and comparative studies of Theobald Smith, however, which attracted special attention to the difference in virulence shown by tubercle bacilli from human and bovine sources when inoculated upon cattle. Smith<sup>60</sup> mentioned also certain morphological and cultural differences in bacilli from these two sources, and in the location and histology of the lesions in cattle produced by such bacilli. He did not conclude, however, that bovine bacilli could not produce disease in the human subject, but said:

It seems to me that, accepting the clinical evidence on hand, bovine tuberculosis may be transmitted to children when the body is overpowered by large numbers of bacilli, as in udder tuberculosis, or when certain unknown favorable conditions exist.

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<sup>a</sup> Report of committee on animal diseases and animal food to the American Public Health Association, at Washington, D. C., October 26-30, 1903.

Koch, however, in his address at the British Congress on Tuberculosis, went far beyond this and maintained that "human tuberculosis differs from bovine, and can not be transmitted to cattle." As to the susceptibility of man to bovine tuberculosis, he said it was not yet absolutely decided, but one was "nevertheless already at liberty to say that, if such a susceptibility really exists, the infection of human beings is but a very rare occurrence." He emphasized this view in the following language:

I should estimate the extent of infection by the milk and flesh of tubercular cattle and the butter made of their milk as hardly greater than that of hereditary transmission, and I therefore do not deem it advisable to take any measures against it.

This conclusion was so radically different from the views of most experimenters and so out of harmony with facts which had apparently been demonstrated by others, that it at once aroused opposition in the congress, followed by the adoption of dissenting resolutions, and led to numerous investigations in various countries. Koch's conclusions were based upon his failure to produce tuberculosis in cattle and other animals by inoculating them with tubercular material of human origin, and his success in causing progressive and fatal tuberculosis in the same kinds of animals when inoculated with tubercular material of bovine origin. With such positiveness did he hold to the constant and specific difference between the human and bovine bacillus that he promulgated an experimental method of discriminating between them. Speaking of the etiology of intestinal tuberculosis in man, he said:

Hitherto nobody could decide with certainty in such a case whether the tuberculosis of the intestine was of human or of animal origin. Now we can diagnose them. All that is necessary is to cultivate in pure culture the tubercle bacilli found in the tubercular material, and to ascertain whether they belong to bovine tuberculosis by inoculating cattle with them. For this purpose I recommend subcutaneous injection, which yields quite specially characteristic and convincing results.

These important and comprehensive conclusions followed from a comparatively few experiments upon animals, and apparently no effort had been made to learn to what extent human tubercle bacilli might differ in their virulence for cattle or what grades of virulence there might be among bacilli of bovine origin. Vagedes had already shown that bacilli were sometimes present in human lesions which were as virulent as bovine bacilli, but his work was wholly ignored by Koch. In the preceding report of this committee reference was made to the work of Ravenel, de Schweinitz, Mohler, De Jong, Delépine, Orth, Stenström, Fibiger and Jensen, Max Wolff, Nocard, Arloing, Behring, and Dean and Todd, all of whom found tubercle bacilli in human lesions which proved to have about the same virulence for cattle and other animals as had the bacilli from bovine animals affected with tuberculosis. Since that report was presented, Theobald Smith has reported the finding of a human bacillus virulent for cattle, and there

has been made a preliminary announcement by Kossel of the results obtained by the German tuberculosis commission. The statement of Kossel should receive the most careful consideration, coming from a commission appointed upon Koch's recommendation, and evidently inclined to favor his views so far as possible in its report.

Kossel<sup>61</sup> stated that the commission had tested 7 cultures of tuberculosis from cattle and hogs—4 from cattle and 3 from hogs. Two of these cultures proved acutely fatal in cattle after 8 to 9 weeks; 4 of the cultures likewise produced a generalized tuberculosis, but which certainly had a more chronic course; while 1 of the cultures caused only an infiltration at the point of inoculation, with some caseous foci in the adjoining prescapular gland and in one of the mediastinal glands, and there was lacking the spreading of the tuberculosis over the entire body, which they were accustomed to see after the injection of cultures of bovine tuberculosis. "Hence," says Kossel, "among bovine tuberculosis bacilli there can also occur differences with regard to the virulence."

The German commission also tested 39 different freshly made cultures from tuberculous disease in man. Nineteen of these cultures did not produce the slightest symptoms in cattle; with 9 others the cattle exhibited after 4 months very minute foci in the prescapular glands, which were mostly encapsuled and showed no inclination to progress; with 7 other cases there was somewhat more marked disease of the prescapular glands, but it did not go so far as a material spreading of the process to the glands next adjoining; there were 4 cultures, however, which were more virulent and caused generalized tuberculosis in the cattle inoculated with them.

It would appear, therefore, that hereafter even Koch must admit that it is impossible always to tell the source of a culture of the tubercle bacillus by its effects when it is inoculated upon cattle. One of the bovine cultures failed to produce generalized tuberculosis in cattle, and some of the human cultures did produce this form of the disease in such animals. Moreover, while some of the human cultures caused no disease at all, others led to the development of minute foci in the prescapular glands, and still others to somewhat more marked disease of these glands. There were, consequently, four degrees of virulence noted in these 39 cultures of bacilli from human sources and three degrees of virulence in the 7 cultures from animal sources.

Now, if we accept the views of Koch as to the specific difference between human and bovine tubercle bacilli, and that the human bacilli produce only localized lesions in cattle, while bovine bacilli produce generalized lesions in these animals, must we not conclude that the one nonvirulent bovine culture was in reality of human origin, and that the animal from which it was obtained had been infected from man? This is a logical deduction, but reverses the dictum laid down at London



that human tuberculosis is not transmissible to cattle. Again, how are we to explain the human cultures of medium virulence? Are they human bacilli which, for some unknown reason, are increasing in virulence and approaching the activity of the bovine bacillus? Or are they really bovine bacilli which have multiplied in the human body until their virulence has become attenuated? In whatever manner these questions are decided it would seem that the findings of the German commission, instead of supporting Koch's views that we can decide with certainty by the inoculation of cattle as to the source of any given bacillus, really show that this method of diagnosis is extremely uncertain in the present condition of our knowledge.

It is definitely admitted that 4 of the human cultures caused generalized tuberculosis in cattle; but Kossel suggests that it might be possible that the bacilli in cases of human tuberculosis under certain circumstances could likewise attain a very high pathogenic activity for cattle without being for that reason bovine bacilli. Undoubtedly the German commission is confronting the two horns of a dilemma, either one of which is fatal to the views of Koch as stated with such positiveness at London. If we accept this suggestion thrown out by Kossel, we must conclude that Koch was wrong in his claim that human tuberculosis can not be transmitted to cattle, and thus with one blow we destroy the entire experimental support which he had for his argument before the British Congress on Tuberculosis. And if, on the other hand, we accept the conclusion which follows from the principle laid down by Koch for the discrimination between human and bovine bacilli, and which appears to be favored by Kossel, we must admit that bovine tuberculosis is an extremely important factor in the etiology of human tuberculosis. Of the 39 cases of human tuberculosis tested, 4, or over 10 per cent, were virulent for cattle and would be classified as of bovine origin; but these 4 cases were all found among the 16 cases of tuberculosis in children which the commission investigated; hence it is plain that 25 per cent of the cases tested of tuberculosis in children would by Koch's method be classified as of bovine origin.

In the Bureau of Animal Industry two distinct lines of experiments have been carried on, in order that one might serve as a check against the other. There has been, however, no discrepancy in the results. De Schweinitz,<sup>30</sup> in the Biochemic Division, Bureau of Animal Industry, has isolated 9 cultures from human tuberculosis. Two of these were derived from human sputum, 3 from cases of generalized tuberculosis in adults, and 4 from cases of generalized tuberculosis in children. By comparing these cultures with a newly isolated virulent culture of bovine tuberculosis, there were found among them 2 cultures from children which were identical in their cultural and morphological characters with the bovine bacillus. These cultures also killed rabbits

and guinea pigs in as short a time as did the bovine bacillus. Hogs which were inoculated subcutaneously with these 2 cultures from children died of generalized tuberculosis. Two calves, weighing over 300 pounds each, were inoculated subcutaneously with these virulent human cultures, and as a result developed generalized tuberculosis. A yearling heifer inoculated with 1 of the cultures showed generalized tuberculosis when killed 3 months after inoculation. Both the cattle and the hogs had been tested with tuberculin and found to be free from tuberculosis before the inoculations were made. It is important to observe in this connection that 2 out of 4, or 50 per cent, of the cultures obtained from cases of generalized tuberculosis in children proved virulent for cattle.

Mohler,<sup>38</sup> working in the Pathological Division, Bureau of Animal Industry, has obtained 3 very virulent cultures of tubercle bacilli from the human subject. A goat inoculated subcutaneously with 1 of these cultures died in 37 days with miliary tuberculosis of the lungs involving the axillary and prescapular glands. This bacillus was obtained from the mesenteric gland of a boy. Of still greater interest is a bacillus isolated by Mohler from human sputum. A goat inoculated subcutaneously with a culture of this germ died in 95 days of pulmonary tuberculosis. A cat inoculated in the same manner died in 23 days of generalized tuberculosis. A rabbit similarly inoculated died in 59 days of pulmonary tuberculosis. Another rabbit inoculated with a bovine culture for comparison lived 10 days longer than the one inoculated with this sputum germ. Mohler also inoculated subcutaneously a 1-year-old heifer with a culture derived from the tubercular mesenteric gland of a boy 4 years of age. This culture was always refractory in its growth under artificial conditions, and the bacilli were short, stubby rods corresponding in appearance with the bovine type. At the autopsy, held 127 days after the inoculation, the general condition was seen to be poor and unthrifty, and large, hard tumors were found at the points of inoculation. On the right side the swelling measured  $3\frac{1}{2}$  by 5 inches, and the corresponding lymph gland was  $2\frac{3}{4}$  inches long by  $1\frac{1}{4}$  inches in diameter. This gland contained numerous calcareous foci; one of these at the apex was an inch in diameter. The lesions on the left shoulder of the animal were very similar to those found on the right side, but the dimensions of the tumor were slightly less. The lungs presented an irregular mass of tubercular nodules, and 7 or 8 grape-like nodules were seen on the parietal pleura. Bronchial and mediastinal lymph glands contained numerous tubercular foci, and the pericardium, peritoneum, spleen, and liver were also affected.

In order to throw some light, if possible, upon the morphological constancy of the different types of tubercle bacilli, Mohler was requested by the chairman of your committee to make comparative

studies of bacilli from various sources, and which had been passed through various species of animals, by making the cultures upon dog serum after the method described by Theobald Smith. Some important results have been obtained. One culture of human bacilli which had morphological and cultural peculiarities similar to those of the bovine bacillus, and which only produced local lesions in cattle, was passed through a series of 5 cats. It was then found to be completely changed in its morphological characters, the rods being elongated, slender, more or less beaded, and entirely of the human type. But far from decreasing in virulence, as might be expected from its morphological appearance, this bacillus had so increased in its pathogenic activity that it now produced generalized tuberculosis in a cow. This cow was inoculated subcutaneously in front of each shoulder with 2 c. c. of a salt solution emulsion of the tuberculous omentum of the last cat of the series. The cow rapidly lost flesh, had a temperature of  $104^{\circ}$  F., with the point of inoculation and adjacent glands greatly swollen. The autopsy revealed generalized tuberculosis, involving the lungs, mediastinal glands, spleen, liver, and kidneys. Tubercle bacilli of the bovine type obtained from the mesenteric glands of a sheep, hog, and cow were similarly transformed in their morphological appearance after being passed through a series of cats and recovered on dog serum. These bacilli also increased in virulence, as the last cat in the series invariably succumbed in a shorter time than the first of the series.

These experiments and observations indicate that the types of tubercle bacilli are very inconstant, and that under suitable conditions they readily change both in morphology and in virulence. A similar conclusion was reached by other investigators in working with the avian and piscine types of tubercle bacilli several years ago, and was reasonably to have been expected with the human and bovine types.

It must be plain to all, from these recent developments, that too much has been made of the slight differences in cultural characteristics, in morphology, and in virulence which have been observed in some cases in comparing the human and the bovine bacilli. The observations were interesting, and it was important that they should be followed up until their significance was made entirely clear; but it was an almost unpardonable error, from a sanitary point of view, to promulgate sweeping generalizations calculated to arrest and abolish important measures for preventing human tuberculosis before the soundness of these generalizations had been established by a thorough course of experimentation.

When Koch said in the British Congress on Tuberculosis that he should estimate the extent of infection by the milk and flesh of tubercular cattle and the butter made of their milk as hardly greater than *that of hereditary* transmission, and that he therefore did not deem it

advisable to take any measures against it, he went far beyond what was justified by any experiments or observations which he reported, and he did an immense amount of harm which will be manifested for years to come to those who endeavor to guard the human race from the dangers of animal tuberculosis. The researches to which your committee has alluded make these dangers more definite and certain than they have appeared before, and sanitarians should therefore most earnestly endeavor to counteract the erroneous and harmful impression which was made by Koch's address at London and his subsequent address at the International Conference on Tuberculosis at Berlin.

Now that the conclusions of the London address are shown to be incorrect and based on insufficient experimentation, it is well that some attention should be given to the Berlin address, in which certain rules were laid down for testing all clinical evidence before it can be accepted as indicating the transmission of tuberculosis from animals to man. While your committee agrees that it is advisable to scrutinize clinical evidence as carefully as possible before it is accepted as influencing the decision of such an important question, consistency demands that we should accept clinical evidence bearing upon the transmission of bovine tuberculosis to man on the same terms that we accept evidence bearing upon the transmission of tuberculosis from man to man. For instance, Koch said in his London address, "So the only main source of the infection of tuberculosis is the sputum of consumptive patients." How does he know this? Has he any evidence to support this conclusion which will stand the requirements which he has laid down for those who oppose his views with reference to the transmission of animal tuberculosis to man? If so, this evidence has not yet been presented. Your committee believes that the principal source of tuberculosis in man is infection from other tuberculous human subjects, but it also believes that a considerable proportion of the cases of tuberculosis in man is due to infection from animal sources; and in weighing the evidence by which we are to fix more rigorously the relation which these two sources of infection bear to each other it is logical that we should apply the same rules of evidence in each case.

The rules which Koch formulated for testing the evidence as to bovine infection are given below, with such brief comments as your committee feels they deserve:

(1) Certain proof of tubercle, and where possible the primary focus must be supplied.

To this condition no objection is raised, but it should be remarked that the location of the primary focus, which is made so much of, is of little value in determining the origin of the infection. It has been clearly shown by various investigators, whose work has been referred to in the preceding reports of this committee, that tubercle bacilli may pass through the walls of the intestine without producing any lesion *at the point of entrance*, and that their first point of lodgment and

multiplication may be the mesenteric glands, the liver, spleen, or even the lungs. On the other hand, Koch has told us that the location of the primary lesion in the intestine is of no significance, because human as well as animal bacilli may be swallowed and may be the cause of such lesions. It is therefore not at all apparent that this is an essential point.

(2) Other sources of infection must be excluded with certainty.

This condition appears to exclude all clinical evidence bearing upon the source of tubercular infection. How is it possible to prove that any given individual has not been exposed to the bacilli of human tuberculosis? And, for the same reason, how is it possible to prove that any given individual has not been exposed to the bacilli of animal tuberculosis? It may be said that this consumptive person had habitually been in a room with another consumptive patient and was infected from that patient; but how can you prove that this person never ate any tuberculous meat, never partook of any tuberculous milk, never ate any butter containing the tubercle bacillus, never had an opportunity to be indirectly infected from the hands of cooks or from table utensils which had been in contact with tuberculous meat, milk, or butter, and was never exposed to the infection scattered in so many ways by tuberculous animals? It is impossible to exclude with certainty all these sources of infection, and if we apply the condition under discussion to the evidence upon which Koch based the assertion that the main source of the infection of man is the sputum of consumptive patients we should find no part of it that would stand the test. Now, is it logical to accept clinical evidence as to the transmission of tuberculosis from man to man by one set of rules and to require an entirely different set of rules when considering evidence as to the transmission of the same disease from animals to man? Your committee is of the opinion that clinical evidence should be regarded as valuable in confirming experimental researches, or in indicating the probable facts where experimentation has been insufficient or is impossible, but that it is too much to expect that clinical evidence will be forthcoming as to the transmission of tuberculosis which will exclude all possible sources of error.

(3) In each case of alleged infection from milk affected with bovine tuberculosis the condition of the rest of the people who have taken the same milk should be borne in mind. These fellow-consumers form to a certain extent a control experiment, and if of the numerous people who have drunk the suspected milk only a single one sickens, this weighs decidedly against the belief that this one person was infected by the common food.

This condition also is regarded by your committee as illogical and impossible of general application without discarding all clinical evidence upon this question. If we apply it to the alleged cases of

sputum infection, we find it is seldom, indeed, that the disease in more than one person can be traced with any probability to the same tuberculous patient, although scores of persons may have been exposed to that patient. Most people who escape tuberculosis have nevertheless been exposed many times to tuberculous patients, but this is not sufficient reason for concluding that others have not contracted the disease by similar exposure. Tuberculosis is a disease which is communicated with such difficulty among people under ordinary conditions of life, by exposure either to diseased persons or to tuberculous food, develops so slowly, and varies so much in the period which elapses before symptoms are observed, that it is only very rarely that groups of cases are observed which even appear to have originated from the same source. And yet how erroneous it would be to exclude clinical evidence suggesting contagion because only one of those exposed to a certain consumptive patient had contracted the malady.

(4) The source of the milk should be attended to. Since in recent years it has become more and more evident that milk containing tubercle bacilli is yielded only by such cows as suffer from tuberculosis of the udders, the general statement that someone has drunk milk from a cow suffering from tuberculosis no longer suffices to prove to us that bovine tuberculosis bacilli have really reached his digestive organs. It must be from a cow with tuberculosis of the udder, and therefore a statement on this subject should not be wanting in a report on milk infection if it is said to be complete.

Your committee finds this statement of fact to be incorrect, since the tendency of recent investigations by competent persons is to make it more and more evident that cows with tuberculosis may yield milk containing tubercle bacilli when the udders present no signs of the disease. The argument is therefore antiquated. Of the many experiments that have been made to determine the proportion of tuberculous cows which yield infectious milk, the average results are about 15 per cent, while the cases of tuberculosis of the udder are about 2 per cent. In recent investigations made by Mohler, of the Bureau of Animal Industry, with 56 reacting cows, it was found that 12 of these, or 21.4 per cent, at one time or another during the experiment gave milk which contained virulent tubercle bacilli. Undoubtedly cows with tuberculosis of the udder yield milk containing a larger number of tuberculosis bacilli than do those in which the udder remains unaffected, and are therefore more dangerous, but it has been clearly shown that other tuberculous cows may yield virulent milk.

So much for the conditions laid down by Koch for testing clinical evidence bearing upon the transmission of tuberculosis from animals to man. The effort to rule out all such evidence by applying impossible tests does not meet with our approval, but fortunately clinical

evidence is no longer necessary for deciding the question. The subcutaneous injection of cattle with pure cultures of the tuberculosis bacillus from human sources, which, according to Koch, "yields quite specially characteristic and convincing results," has proved, in the hands of the German commission no less than in those of independent investigators, that bovine tuberculosis is communicable to man. It will require much work to decide with even approximate accuracy the proportion of human tuberculosis caused by animal infection; but the fact that 25 per cent of the cases in children investigated by the German commission, and 50 per cent of similar cases investigated by de Schweinitz, showed by this test that they were caused by animal infection is sufficient to convince us that measures should be taken and enforced at once to guard against infection from this source.

In concluding, your committee desires to express its appreciation of the prompt, intelligent, and indefatigable work of those scientific investigators who took up this question immediately after it was brought to the front at London, and in the comparatively short period of about two years have furnished the material for definitely settling it, so far as the principal contention is concerned.

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